LABOURS OF TECHNOLOGY: CARBON CAPTURE AND STORAGE IN ALBERTA, CANADA

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(GEOGRAPHY)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

JANUARY 2016

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Abstract

Since the mid 2000s, carbon capture and storage technology (CCS) has become an important component of climate change policy, and in some jurisdictions is the central state strategy for climate change mitigation. Although carbon capture technology has garnered attention as a so-called 'technological fix' for climate change, less is known about how it is enrolled in processes of knowledge production, and in the regulation of spaces, processes and people for the purposes of carbon control. Using the case study of Alberta, Canada - a high-income hydrocarbon producing jurisdiction - this dissertation investigates how CCS technology operates as a political technology, that is, as an instrument that produces new ways of thinking about and managing complex political issues. The research investigates what procedures, techniques, and modes of analysis enabled CCS to become the primary climate change mitigation instrument/policy of the Alberta government.

The strategy for addressing climate change through carbon capture is situated within the regulatory and institutional historical context of Alberta's hydrocarbon-based political economy. CCS is assessed as a 'technological fix' that enables the Alberta provincial government and associated actors manage the province's triple climate crisis, consisting of the impacts of climate change, and attendant issues of social legitimacy and market access for the province's hydrocarbon exports.

Expert and participant interviews, and documentary analysis demonstrated that CCS expertise and capacity within the province were strategically translated from existing oil and gas technological and institutional capacities. Yet, advancing carbon capture as a carbon control measure necessitated the incorporation of additional scientific and economic rationalities, institutional and regulatory capacities, and extra-jurisdictional expertise.

I find that overall, carbon capture and storage has failed as a technological fix for Alberta's carbon control crisis because some of the very factors that led to its rapid ascendancy as a carbon control measure – a resource strong advocate community, its continuity with an existing political economic pathway, and others – made it susceptible to disruption from exogenous events, notably a climate policy vacuum and competition from other energy technologies.

Preface

The identification and design of this research program, performance of this research, and analysis of this data were undertaken by the author, Emilia Kennedy. The resulting dissertation is an original intellectual product.

UBC Behavioural Research Ethics Board approved the fieldwork reported in these pages (certificate number H12 – 021116 'Carbon Capture').

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List of Acronyms and Abbreviations

ACCSDC	Alberta Carbon Capture and Storage Development Council
AERI	Alberta Energy Research Institute
AGD	Acid gas disposal
AI-EES	Alberta Innovates – Energy & Environmental Solutions
AI-TF	Alberta Innovates – Technology Futures
ANT	Actor-network theory
AOSTRA	Alberta Oil Sands Technology Research Authority
ARC	Alberta Research Council
BAU	Business-as-usual
CCS	Carbon capture and storage/sequestration
CCSTRM	Carbon Capture and Storage Technology Road Map
CO_2	Carbon dioxide
COP	Conference of the Parties (decision-making body of the UNFFC)
CORDNET	Carbon Dioxide Research and Development Network
CSLF	Carbon Sequestration Leadership Forum
EDA	Environmental discourse analysis
EETF	EcoENERGY Task Force (CCS)
ENGO	Environmental non-governmental organization
EOR	Enhanced oil recovery

ERCB	Energy Resources Conservation Board
ESRD	Environment and Sustainable Resource Development (Government of Alberta ministry)
GHG	Greenhouse gas (carbon dioxide, methane, etc)
GCCSI	Global CCS Institute
GoA	Government of Alberta
ICO2N	Integrated Carbon Dioxide Network
IEA	International Energy Agency
IEA-GHG	International Energy Agency – Greenhouse Gas Programme
IOC	International Oil Company (privately held; not state owned)
IPCC	Intergovernmental Panel on Climate Change
NGO	non-governmental organization
OAGA	Office of the Auditor General of Alberta
RD&D	Research, Development and Demonstration
RFA	Regulatory Framework Assessment
SGER	Specified Gas Emitters Regulation (Alberta carbon charge regulation)
SRCCS	IPCC Special Report on Carbon Dioxide Capture and Storage
STS	Science and technology studies
UNFCC	United Nations Framework Convention on Climate Change

Acknowledgements

Firstly, I would like to acknowledge and thank my supervisory committee, Dr. Merje Kuus, Dr. Karen Bakker, and Dr. Jamie Peck. I extend particular thanks to Merje for helping me focus in on heart of my argument, and for supporting me at every stage of my trajectory. Jamie, for the second degree in a row your work helped explain my objects of inquiry more than I'd anticipated. Thanks for being on the ball. I would also like to thank my examining committee - Dr. Simon Dalby, Dr. George Hoberg, Dr. Dan Hiebert, and Dr. Gary Bull.

I was also bolstered and encouraged by the academic advice of Dr. Philippe Le Billon, Dr. Geoff Mann, Dr. Eugene McCann, Dr. Graeme Wynn, Dr. Anna Zalik, and Dr. Matthew Huber. I am also deeply appreciative of the mentorship and ongoing support of Dan Wollyniwicz, and thank the Geography Department for hosting the Professional Leadership Network that led to our mentorship.

I am tremendously grateful for the support of the Social Sciences and Humanities Research Council, through the Joseph-Armand Bombardier CGS Doctoral Scholarship. I also thank the UBC Liu Centre for Global Issues for their support of the 'Carbon Economies' project with Sophie Webber.

I also extend my deep gratitude and affection for the intellectual comraderie and lasting friendship of my Departmental colleagues Dawn Hoogeveen, Andrew Shmuely, Max Ritts, Tom Howard, Alyssa Stryker, Emily Rosenman, Melanie Sommerville, Sophie Webber, Jamie Doucette, and Molly Kraft, as well as my 'brothers from another alma mater,' Am Johal, Brett Dolter, Dave Campanella, and Geoff Dembicki. My time at UBC Geography was enriched and eased by Leigh Barrick, Sarah Brown, Suzanne Lawrence, Sandy Lapsky, and Jeanne Yang.

I also thank the teachers and healers who kept me in survive and thrive in body, mind and soul: Dr. Elsie de Vita, Dr. Tanya Gee, Dr. Juan Ruiz Naupari, Karl Notargiovanni, Reno Meunz, Alli

Schafer, Danielle Hoogenboom, Dr. Suzanne Slocum-Gori, Heather Muir, Dr. Karen Stancer, and too many others to mention.

Lastly, I owe deep thanks to the friends and family who give me continuous strength and joy: Charlotte Falk, Laura Kozak, Carmen Douville, Daniela Aiello, Erica Holt, Leanna Killoran, Christyn M. Hall, Elizabeth Locke, Alexander Muir, James Reimer, Lauren Reynolds, Lindsay Reynolds, Paul Robinson and many more, including the indefatigable Mike Hudema and Scott Harris for keeping it real in Alberta.

Last but not least I owe a special, heartfelt thanks to my mother and grandparents who have supported in all possible ways throughout the long journey of post-secondary education.

Chapter 1: Politics and Technology in the Age of Carbon Control

"A fresh instrument serves the same purpose as foreign travel; it shows things in unusual combinations."

– A.N. Whitehead, *Science and the Modern World*

"*Knowledge, the object of knowledge, and the knower are the threefold motivators of action; instrument, act, and agent comprise the action itself.*"

– The Bhagavad Gita

1.1 Carbon Capture and Storage and the Strategic Address of Climate Change

As climate change has become the dominant environmental issue of our time, some commentators have begun to claim that it is the defining political issue, writ large, of the 21st century. Climate change increasingly acts as the background condition through which others matters of political, environmental, and social concern are understood. The more-than-climactic changes which seem to accompany the anticipated future of unmitigated anthropogenic climactic changes leave Ulrich Beck and Joost van Loon to argue that it represents a "change of change," a "meta-change" to the world as we know it (2010). Yet, while we might anticipate that climate change changes everything, it is more difficult to delineate exactly how this may be so. Just as physical scientists describe the probabilities of irreversible discontinuous change to ecosystems, social scientists attempt to think through the ways in which climate change is conditioned by existing political configurations, even as it produces them. My underlying motivation for undertaking this research is to consider both the ways in which climate change is modulated by existing political relations, and at the same time how climate change has already begun to reconfigure them. I focus in particular on the relations governing the nexus between climate change and high-carbon energy production.

An analysis of the consequences of climate change for the political, and of the political for climate change, entails a three-step investigation of climate change as a politico-historical conjuncture. First, it is necessary to understand what existing governance conditions and capacities (be they political, economic, institutional or technological) are being brought to bear as ways of addressing climate change. The second step is to detect and describe the changes to existing political and social formations that climate change has already brought about. A third step involves understanding the role of knowledge and knowledge-production in the first two steps. If a crucial axis of governing is forms of knowledge and expertise drawn upon to govern (Rose and Miller 2008: 17), it is necessary to investigate how the types of knowledge used to think through the energy-climate nexus configure a governance response. This is particularly salient in the case of climate change. More so than any environmental problem that sparked questions about cause and responsibility - like DDT contamination, nuclear radiation or bee colony collapse – the path from climate change as a 'matter of concern' in the 1980s to a 'matter of fact' (Latour 2004) has been marked by an unprecedented politicization of the key pillar of Western knowledge, scientific inquiry.

Despite the convulsions and obfuscations of denialism and the climate change knowledge-controversy, there is now a scientific consensus around both the anthropogenic origin of climatic changes already in process, and around the need to drastically curb the emission of greenhouse gases responsible for climate change. Even former deniers (e.g., ExxonMobil, US President Bush) now recognize that a rapid global transition away from carbonized fuel needs to happen with urgency.[1] The result is that climate change is now also a 'matter of fact' in the political field: virtually every nation-state has a climate change plan, and governments, businesses and large-scale

[1] Anthropogenic greenhouse gas emissions (such as carbon dioxide, but also methane and f-gases) derive from a range of sources, such as agricultural practices, land cover and land use change and deforestation. But the single largest share derives from the combustion of hydrocarbons for energy, fuel and transportation (IPCC 2007). Fossil fuels account for fifty-seven percent anthropogenic greenhouse gas emissions (IPCC 2007). In the global energy supply chain, fossil fuels account for 81.2% of total primary energy supply, where oil accounts for 36.3% of world's supply,[1] coal/peat for 20.0%, and natural gas 24.9% (International Energy Agency 2014).

actors are motivated to communicate their role in helping combat climate change, lest their legitimacy be tarnished by the 'climate laggard' title. This is of particular salience to both Canada and Alberta, who are the fifth and ninth largest oil producing jurisdictions in the world by yearly production volume in the world, respectively (US Energy Information Administration 2014b, Alberta Energy 2014c, 2014d).

Strategies for climate change mitigation, or "carbon control" (While, Jonas and Gibbs 2010) demonstrate the patchwork of possibilities for decarbonization. Among a range of strategies for carbon control - from international treaties and cap-and-trade schemes, to fuel switching, efficiencies and changes in consumption patterns – carbon capture and storage/sequestration (CCS) technology is being proffered in some high-consuming and/or high-fossil fuel production jurisdictions as a strategy to manage carbon in the context of hydrocarbon-based energy systems.

CCS, or what I will henceforth refer to as 'carbon capture,'[2] is essentially a pollution abatement technology designed to keep carbon dioxide emissions from fossil fuel combustion from entering the atmosphere. It is a is a composite technology consisting of three- or four-processes: the physical/chemical removal of carbon dioxide from processes, usually from large point sources, like fossil fuel power plants or oil upgraders; transportation; long-term storage; and lastly, sometimes included, measurement, monitoring and verification (MMV). The separate components of CCS technology, at least forms of all of them, are not in themselves new. Rather, it is the combination of the four stages together, most often for the purposes of climate change mitigation (although see below, and Section Chapter 4) that makes CCS a distinct technology.

There are three forms of capture technology used in CCS processes: post-combustion, pre-combustion, and oxyfuel with post-combustion. Post-combustion processes separate CO_2 from the exhaust gases resulting from combustion, capturing CO_2 using a liquid solvent or other methods.

[2] I refer to CCS as carbon capture whilst recognizing that storage/sequestration is an equally important aspect of its technological function. The shorthand was developed for ease of reading, and the reader should understand 'carbon capture' to refer to the whole technological suite of carbon capture and storage/sequestration.

This method is already widely used in the food and beverage industry. Pre-combustion capture converts fuel into a gaseous hydrogen and carbon dioxide. The conversion process is more complex than post-combustion processes. Oxyfuel combustion uses pure oxygen instead of air for fuel combustion, producing exhaust gas consisting of water vapour and an easily separable high purity CO_2 stream. All of these capture methods require significant energy expenditure: in the case of a coal-fired CCS plant, Metz et al. 2005, estimate that CO_2 capture and would increase fuel by 25–40%. Storage can also take several forms, including deep ocean and mineral storage. But the overwhelming majority of CCS projects involve geological storage of carbon dioxide in underground formations like depleted hydrocarbon deposits, or saline aquifers.

There is also a related-suite of technologies known as bio-energy with carbon capture and storage (BECCS), which can produce net negative emissions by combining biomass energy with geological carbon capture and storage. Furthermore, other technologies and techniques fit under the umbrella of carbon capture and storage, depending on the how wide of a definition one gives to the term. For instance, there are other non-BECCS forms of carbon dioxide removal technologies such as biochar, and carbon dioxide removal through passive air capture (discussed in Chapter 7). Moreover, as I discuss at length in Chapter 4, the techniques associated with geological storage of carbon dioxide were adopted from enhanced oil recovery (EOR) technology, which is used by the oil and gas industry to re-pressurize wells in order to extract additional reserves out of ground.

It should also be noted that there is both a semantic and material distinction to be made between sequestration and storage. While the former refers to permanent removal of carbon dioxide from the atmosphere, the latter implies the possibility of non-permanent storage. This, of course, raises the question of the degree to which the application of the technology is a climate change mitigation tool. Furthermore, some refer to "carbon capture and storage and utilization," as is the case with enhanced oil recovery, further extending both the limits of what constitutes CCS

technology, and even further pressing the question of whether CCS should be considered a climate change mitigation technology, unless specified.

When people refer to "carbon capture and storage" technology, they are most often used to refer to a technology suite that captures carbon dioxide from large point-source industrial sources and geologically sequesters or stores it. This is the "classic" connotation of the technology if there is one. However, the preceding paragraphs underscore that "carbon capture and storage" technology is both a suite of technologies, and that the specific components, means and ends of the technology can be highly variable, depending on the specific project in question.

In the first decade of the new millennium, CCS gained importance in both national and international policy agendas, moving to the center of climate policy in many jurisdictions (IPCC 2005, IEA 2008, de Coninck 2010, Meadowcroft and Langhelle 2010, Stephens et al. 2011), and acting in some cases as the central state carbon control strategy to mitigate climate change (Bäckstrand et al. 2010). This attention has been associated with, and fueled by, an increase in both public and private investment in CCS (ACCSEPT 2007, Tjernshaugen 2008, Climate Group, Ecofin, and Global CCS Institute 2010).

CCS technology has emerged front and centre in the efforts of Canada's major fossil fuel producing jurisdictions, Alberta and Saskatchewan. In 2008, the Alberta government released its *Climate Change Strategy*, a policy aimed to stabilize and reduce emissions by 50 megatonnes by 2020, and by 200 megatonnes by 2050, with CCS technology accounting the majority of those reductions.[3] That same year, the province announced its creation of a $2 billion direct subsidy for CCS demonstration projects that would represent a first wave of actions to propel the province towards its climate change mitigation targets. Four projects were created with the fund: the Shell Quest deep saline aquifer storage project ($745m); the Alberta Carbon Trunk Line project, which

[3] In the plan, carbon capture accounts for 139 Mt of 200 Mt expected reductions in 2050 (Alberta Environment 2008: 20). A 200 Mt reduction would represent total GHG emissions 14 per cent below 2005 levels.

would transport carbon dioxide to existing mature oil fields for enhanced oil recovery (EOR) ($495m); the TransAlta Pioneer project ($770m), that would retrofit a coal-power plant, and similarly use CO_2 for enhanced oil recovery; and the Swan Hills Synfuel project, an in-situ coal gasification (ISCG) project that will used carbon dioxide to convert coal into a synthetic gas known as syngas ($285 million).

In 2011-2012, the government undertook an intensive multi-stakeholder assessment of relevant existing regulation and legislation, all of which both leveraged the province's existing technical and institutional fossil fuel infrastructures, while at the same time reshaping them. These three components – the dominant role for carbon capture in the *Climate Change Strategy*, the $2 billion subsidy, and the regulatory assessment – constitute what I will refer to as the project of developing carbon capture in Alberta. This project is discussed in relation to Alberta, Canadian and international efforts in more detail in Chapter 3.

The selection of carbon capture and storage as a carbon control strategy of choice can be directly related to the political economy of the province. While hydrocarbon production has brought Alberta tremendous prosperity, it has also made it dependent on the fossil fuel revenues, making it vulnerable to changes and crises. Starting in the early 2000s, Alberta's oil sands[4] sector expanded rapidly, leading to increased total energy production. But this also increased provincial greenhouse gas emissions. The result was that the province's emissions were increasing rapidly right at the time when the global consensus on the need for carbon control, and drastically *reducing* greenhouse gas emissions was being forged.

[4] A note on terminology: I use the terms 'oil sands' and 'tar sands' interchangeably throughout the dissertation. I understand that this might frustrate the reader, however the choice to not choose is deliberate. In popular discourse, the term 'oil sands' is used as a supportive or tacitly supportive (qua 'neutral') term for Alberta's bituminous sands, while 'tar sands' is used by voices critical of aspects of their development. In my view, the fact that political contestation over this form of energy development can be condensed and coded in a singular binary terminology is fascinating. Since my empirical account is based off of interviews and readings of voices across the spectrum from support to opposition, my terminology choice at a given instance offers a trace of empirical sources. According to Le Billon and Carter, "[u]sing the term 'tar sands' is considered as evidence of a bias against their exploitation since industry and governments actors insist on the usage of 'oil sands'" (2012: 8). This should be tempered by the fact that it is more widely used in the foreign press as opposed to the Canadian press.

As a result, the exploitation of the oil sands began to register international attention, and has in recent years become a focus of international exposure and pressure for groups working to combat the environmental consequences of continued fossil fuel development. This exposure and pressure has produced a crisis of legitimacy for the Alberta government and oil sands operators, which has subsequently evolved into a crisis of market access, described in Chapter 3. Henceforth, I will refer to this as Alberta's "carbon control crisis" or "triple climate crisis," which consists of the biophysical problem of anthropogenic climate change, plus the political legitimacy and market access problems resulting from Alberta's carbon-intensive fossil fuel reserves. As such, "carbon control" refers not just to controlling carbon, but also to governing all the problems associated with carbon in the era of excess carbon.

A close examination of this technology and the project for its development provide an avenue for considering the underlying concern of this dissertation. By examining the ways in which jurisdictions such as Alberta are advancing CCS, one can illuminate: how existing governance conditions and capacities are being brought to bear *on* and *through* carbon capture and storage as a way of addressing climate change; how, as an instrument of 'carbon control,' CCS signals changes to existing political and social formations already brought about by climate change; and lastly, how CCS plays a role in the mutually conditioning intersections of governance and knowledge-production.

Using theoretical contributions from scholars working within governmentality frameworks, which are based on the work of Michel Foucault, this project is focused on how CCS technologies and policies "do the work" of (socio-)carbon control by working on and through social practices, institutions, policies, and the actions of agents (Mosse 2004, Li 2007). Such an investigative approach focuses on the conditions of possibility of the regulation of social practices: the rationales, forms of authority, and knowledge claims underlying regulation. It directs the investigator to attend to the socially mediated articulations between means and ends – how particular decisions,

narratives, subjectivities and processes come to be attached to given policies and technologies (Dean 2010: 39), as well as the conditions under which such articulations emerge (Watts 2003).

1.2 Objectives and Research Questions

The objective of the dissertation is to understand why and how CCS is being developed in Alberta, and to what effect, with particular regard to how carbon capture operates as a political technology, *that is, as an instrument that produces new ways of thinking about and managing complex political issues* (discussed further below). This objective necessitates the development of an in-depth account of: a) a complex, multi-scalar social process – the trajectory of CCS technology and policy as a political technology, b) the historico-geographical specific context of the energy political economy of Alberta, and c) the mutually conditioning of the conjunction of process and context. To study carbon capture as a political technology is to be interested in how Alberta CCS projects are assembled within the context multiple variously converging or countervailing processes. Using a series of theoretical and methodological tools for understanding that are introduced in Chapter 2, the dissertation investigates why and how CCS is pursued as a strategy for governing carbon. The project will empirically investigate the techniques, rationalities, and modalities through which CCS is enlisted to do political work (whether to govern, to rule or to contest such rule).

This project is founded on the normative assumption that the governance of social practices has an irreducible political dimension. Since governance entails a claim to particular legitimate authority, it follows that other truth claims or other loci of authority are diminished in the process. As such, 'what is' in terms of the manner in which energy and climate change are managed could 'be otherwise.' Thus, this work is motivated by a desire to understand what is politically at stake in the unfolding regimes of carbon control, such as carbon capture and storage. Accordingly, this research project investigates the role expert discourses (such as scientific and economic authority), scientific

and engineering practices, legal and regulatory mechanisms, and expertise itself, play in shaping the political contours of energy and climate change management. Such discourses, practices and mechanisms constitute the political technologies of carbon control.

In this project, I contend that by studying what will come to be revealed as an unexpected failure in the trajectory of carbon capture, one can apprehend key historical moments in the larger the social and political context in which it is unfolding. In the process I register a number of important features about the contemporary political geographies of climate change, energy, and contemporary politics more broadly. Although carbon capture technology has garnered attention as a so-called 'technological fix' for climate change, less is known about how it is enrolled in processes of knowledge production, and in the regulation of spaces, processes and people. This project will fill in some of this knowledge gap, investigating several dynamics of contemporary politics with which carbon capture is linked: the role of the state in planning and promoting technological and economic pathways, scalar and institutional changes in governance and state-making practices, including emerging articulated systems of state and non-state governance, and the effects of selective incorporation of knowledge into climate change governance.

Carbon capture and storage has been criticized as a mere 'techno-fix' for what are essentially social and political problems. Yet this critique, as Chapter 2 will show, constructs a binary, positing technology somehow antithetical to more socially mediated solutions for problems. To counter this binary, this project investigates how 'hard' (physical, infrastructural) technologies such as CCS operate as components of larger 'soft' technologies of rule. An investigation of the effort to develop CCS can show that any supposedly "technological" approach to a problem requires a vast undergirding of social support in the form of policies, regulation, personal and professional networks, and supporting narratives that help legitimate the technology. Such an exercise is necessary in order to understand not only that so-called technological fixes to problems are in fact thoroughly social, but also how socio-technical interventions like CCS *appear* as asocial or apolitical

solutions: CCS presents an opportunity to investigate empirically how social problems are "rendered technical" (Li 2007). This is empirically demonstrated by paying attention to the role of knowledge (science, policies, expertise) and political technologies (techniques, rationalities, and modalities of governing) in creating and maintaining the conditions of possibility of technologies and regimes of carbon control. As such, it is possible to investigate key moments in the development of carbon capture in Alberta as social processes through which technical expertise and judgment become authoritative. This process is particularly salient with a complex 'wicked problem' (Levin et al. 2012), like climate change, where the work of experts is required to narrow the field of uncertainty, structure action, and to frame what is included and excluded as relevant to an issue.

This research project critically investigates what particular conjuncture of processes led actors to uptake of CCS as the cornerstone of climate change mitigation in Alberta. It assumes that this technology necessarily works to bring about not only reductions in GHG emissions, but also generates, maintains or disrupts larger arrangements of knowledge, power, capital, and social relations. The central question of my dissertation research is: <u>how does geological carbon capture and storage technology 'do work' as a political technology – that is, as an instrument that produces new ways of thinking about and managing complex political issues</u>?

In order to focus this larger question, I posed three additional supporting questions that helped focus fieldwork:

1. <u>How - that is through what procedures, techniques, and modes of analysis - did CCS become the primary climate change mitigation instrument of the Alberta government</u>?
2. <u>How do the various fields of expertise brought to bear on CCS condition both the technology's trajectory and its field of governance?</u>

3. <u>What political economic dimensions specific to Alberta have a bearing on the trajectory of CCS?</u>

Guided by these questions, the dissertation research constitutes a context-specific, detailed account of how the co-production of hydrocarbon political economies, knowledge, science and expertise, the state and activities of governance, intersect with the uncertainties of climate change and contemporary politics to produce new ways of knowing and managing complex political issues.

1.3 Scholarly Context

The motivation to take on this research project was first and foremost to develop a greater understanding of the articulations and overlap between climate change and energy systems. In his assessment of 'carbon geographies,' Gavin Bridge argues that, "[e]nergy and climate traditionally have been 'relatively discrete' academic and policy domains and in many jurisdictions they remain so" (2011: 3; see also Lovell, Bulkeley and Owens 2009). Yet Bridge elucidates how energy systems and climate change are metabolically and socially joined as "the yin and yang of a high-energy, fossil fuel society" (2011: 523; see Woynillowicz and Smith 2013 for the Canadian context). As such, a complete apprehension of the contemporary geographies of energy systems and the climate conundrum requires an integrated consideration of both. Bradshaw similarly contends that, "it is only relatively recently that the interrelationship between the two issues has become the focus of academic research and policy making," and that a new focus is required to consider the issues simultaneously (2010: 276; see also O'Brien 2006: 3). Because of they are in many ways the two sides of the same coin, Bridge suggests geographers should work to detect and analyze how 'old' (fossil fuel-based) and 'new' (climate control-based) carbon economies operate as extensions of each other (2011: 10). When Alberta announced its $2 billion direct subsidy for demonstration CCS projects in 2008, I recognized that carbon capture and storage technology stood right at the

intersection of energy and climate change systems, both in terms of policy and the function of the technology itself. As such, I knew CCS would help to illustrate one of Bridge's contentions – that when "the old and new carbon economies collide in the *same* geographical space, … tensions and mutual dependencies are exposed with a particular clarity" (2011: 10).

I was also motivated to pursue an investigation of carbon capture and storage technology because my initial assessment of its potential as a greenhouse gas emission mitigation strategy was essentially agnostic. I saw validity in the claims made of its potential to be a technology for emissions reduction, yet I was curious as to whether scarce resources funneled into it would detract from efforts to move beyond carbon. Skeptical voices have dismissed CCS as simply "greenwashing" or "public relations" (Le Billon and Carter 2012), but I found the range of actors and institutions involved in the CCS network and the history of the technology did not support such a simple answer.

An additional motivation for investigating CCS in Alberta was to develop an understanding the hydrocarbon-based political economy of Alberta. This was based on a highly personal motivation: having grown up in Alberta and resided there for 25 years, I have had the privilege and frustration of living in a place so blessed with natural resources, yet so often managing these resources without a long-term strategy. As a senior undergrad, I did volunteer research to map the socio-environmental contours of oil sands development in the Athabasca oil sands region with a colleague. At this time very few people around the world, in Canada, or even Alberta, were paying attention to the new and accelerating forms of unconventional oil production occurring in northern Alberta. Despite the massive increase in public awareness of the social, political and ecological consequences of energy development in the province, empirically rich social scientific studies of energy exploitation and environmental implications in Alberta's are relatively thin (but see Le Billon and Carter 2010, Haluza-DeLay 2012, Zalik 2012, Zalik 2015, Carter and Zalik forthcoming, and Adkin forthcoming). Thus, the research will attempt to account for how CCS technologies

gained a central place in Alberta's approach to climate change, attending specifically to the interactions between place-specific processes, like existing expertise in oil and gas and analogous technologies, and international dynamics, revealing how international processes operate through the place-specific pathways, and vice versa.

1.3.1 Contribution

This dissertation adds needed empirical study of the socio-political dimensions of the energy-climate nexus in Alberta and Canada, from a critical social science perspective. But what can the social sciences contribute to understanding climate change, and the new sorts of politics and interventions, such as CCS, being produced as a result of efforts to mitigate it? In their response to this question, sociologists Ulrich Beck and Joost van Loon (2011) make a distinction between a "*future* of catastrophic climate change to come" and the "*present anticipation* of a catastrophic future," arguing that the former lies in the realm of the physical sciences, while the latter should be the primary concern of social scientists. The politics of climate change are socio-political phenomenon in the present, produced through anticipation of the future, which make possible the altering the very future catastrophes anticipated in the first place (Dalby 2013). A study of how CCS operates as a political technology, and as a contested socio-technical form of carbon control, can be studied as a case of the present anticipation of catastrophic climate futures.

What role, then, does a specifically geographical lens bring to understanding the present anticipation of climate change? Arguably, the two central questions being asked about climate change are: what can be done about it, and how? Both of these questions are thoroughly political (by *whom* and how), as well as inherently geographical (*where* and how). As such, there is a need for contributions from human geographers who might have things to say in recognition that "there is a complex spatial politics to climate change" (Barnett 2007: 1361). Over the last several years,

human geographical scholarship has developed a dynamic, critical body of work on the economics and politics of climate change (Barnett 2007, Dalby 2013). Dalby recently traced the contours of a political geography of climate change, finding deep connections between geopolitical practice (in its classical sense as a "cultural representations of the earth"), geophysical knowledge, and climate change (2013: 39). For Dalby, the connections between politics, knowledge and climate change reinforce a central tenet of critical geopolitics - that "the modes of knowledge, of ways of representing the world that have political consequences" (2013: 38).

He suggests that in geography, particular attention has been paid to the contours, processes and implications of a 'new' carbon economy – emissions trading, carbon commodification, and other market-based endeavors with the putative goal of mitigating climate change risks (Paterson and Newell 2009, Lansing 2010, Boyd, Boykoff and Newell 2011). Overall, geographers have been successful at tracking the ways in which novel political and economic transformations caused by climate change have led to the reproduction and re-entrenchment of neo-colonial logics and uneven capital accumulation (Bridge 2011: 10).

Human geography has also produced a body of scholarship on the socio-political dimensions of energy, especially oil (Watts 2004, Labban 2008, Reed 2009, Huber 2009, 2013, Bridge and Le Billon 2012). Though as Bebbington contends, the sub-soil has been "essentially absent" human geographical study, suggesting that "[p]erhaps this very omnipresence [of mined materials] has made the centrality of the sub-soil too big to get a handle on, or too mundane to recognize" (2012: 1159). Few scholars have attempted to work specifically at the energy-climate nexus, despite the fact that it offers a 'carbon optic' that acts as a unifying conceptual apparatus (Bridge 2011). This research is an attempt to contribute explicitly to a consideration of the energy-climate nexus, both empirically and for its possible theoretical contributions. This dissertation offers both an up-close empirical look of the geographies of expertise and governance by 'studying

up' (Nader 1972), and offering the only human geographical scholarship to date to explicitly investigate carbon capture and storage technology.

There is currently a small, but growing body of scholarship outside of geography on the social and policy aspects of CCS, discussed briefly in Chapter 2 (Langhelle and Meadowcroft 2010, special issue of *Global Environmental Change* 2011, Markussen et al. 2012). Most work social science work on CCS is semi-applied or policy-oriented (see *International Journal of Greenhouse Gas Control*, *Energy Policy*). The social science research on CCS in Canada is mainly applied and policy-focused, with the aim of advancing the development of CCS (Sharp and Jaccard 2010, see also Hellin 2008; but see also Campanella 2011).

1.4 Findings and Structure of the Dissertation

This final section of the introduction lays out both the central findings of the research, and the contents of the remaining chapters.

First and foremost, the dissertation finds that the project of developing carbon capture in Alberta (through the *Climate Change Strategy*, the $2 billion subsidy, and the regulatory assessment) was, overall, a failure of carbon control and a failure to address the province's triple carbon crisis. We will see that the CCS carbon control strategy ultimately manifest as a 'proto-fix' rather than as a successful technological fix. This research will show that some of the very factors that led to the rapid ascendancy of carbon capture as a governance strategy – a resource-strong advocate community; its continuity with an existing political economic pathway; the confluence of resources, technology, funding and policy aims; validation from techno-scientific organizations and models – made it susceptible to disruption from exogenous events.

This and the following six chapters lay out a historical trajectory whereby, despite (and in some cases *because* of) the momentum of political economic pre-eminence (Chapter 3), the

consolidation of resources, technology, funding and policy aims (Chapter 4), regulatory support and external validation (Chapter 5), as well as validation from techno-scientific organizations and models (Chapter 6), a coalition of powerful actors were unable to realize the technological fix that could address threats to their favoured economic pathway. Put differently, although backed by powerful actors, carbon capture and storage has not been successfully realized, not least because many factors influencing the technology's trajectory were occluded from the calculus of its advocates. Seen through the lens of political technologies – this dissertation will demonstrate that where there are disjunctures within a regime of carbon control between devices and techniques; expertise, knowledge and skills; and institutionalized practices, governing actors are limited in their ability to shape the field of action in question.

Thus, the dissertation research was conducted in order to process trace a technological fix, when in the end, I found I was following an aspirational fix – a project of technological envisioning that was strategically vital for the interests of the actors I followed. Carbon capture was a concrete intervention these actors could anticipate in the face of Alberta's growing triple climate crisis, and yet (strategically) unforeseen circumstances meant the intervention has stayed, with one exception, within the discursive realm. Furthermore, some of the very same factors that lead to the rapid ascendancy of CCS as a carbon control strategy also constrained its implementation and impact.

In short, the dissertation charts the rise and precipitous fall of a techno-regulatory project and the groups assembled to advance it. Such an outcome was neither surely anticipated by myself when I initiated this research in 2010, nor, as the dissertation will reveal, was it likely anticipated by the actors who had commenced working for carbon capture as a mitigation technology in the province as far back as the early 1990s. As a result, the dissertation did not follow as a normal path of analysis for many of the literatures upon which my theoretical lenses were based, which I discuss further in Chapter 2.

In that chapter, I elaborate the conceptual foundations of the project, which I group under four broad areas of study: geographical political economy, governmentality studies, critical policy studies and actor-network theory. I introduce key concepts furnished by each area of literature, as well as elaborate on the specific contributions of critical policy studies and actor network theory. I also detail my project methods in this chapter.

Chapter 3 introduces the empirical context for the case study. Here, I introduce the broad contours of Alberta's fossil fuel-based economy from a political economic perspective, discussing how both energy and pollution have been regulated and managed. I sketch a picture of the current landscape of energy politics in Alberta and Canada, notably the public spotlight that has been turned to the Alberta oil sands/tar sands since the mid-2000s. I will show that the motivation to pursue carbon capture on the part of Alberta's hydrocarbon interests can be traced to growing civil society demands for addressing climate change. I elaborate how carbon capture enables Alberta's hydrocarbon community to reconcile a fossil fuel-dependent economic development path with the need to address the climate impacts it produces.

In Chapter 4, I trace the emergence of carbon capture and storage technology as new way of managing the complex problems associated with the climate change impacts of fossil fuel production. I show how, in response to anxieties about the potential impacts of climate change regulation on hydrocarbon development, enhanced oil recovery (EOR) technology, a technology to increase oil production, was transformed into a new object – carbon capture and storage (CCS). In the process, I trace the emergence of the community that supports, and is supported by, CCS. The chapter is a detailed empirical history, one that is required in order to demonstrate the iterative, but cumulative, way in which carbon capture garnered the technical, advocacy, policy and regulatory support of resource-strong actors.

Chapter 5 continues the detailed history of the CCS community to its contemporary (2008-) activities. The chapter explores in particular the 2011-2012 Regulatory Framework Assessment

(RFA), which was undertaken by the Alberta government and major stakeholders in the Alberta CCS community, as well as participants from neighboring provinces and international organizations. The chapter shows how the successful construction of CCS as a political technology in Alberta is a process not only of translation from older oil and gas political technologies, but is also a composition that entails drawing in additional actors. I discuss how the effort to advance CCS involves not only the crossovers between science, state and economy, but also relies on, and produces hybrid expert subjectivities, who work both 'inside' and 'outside' the boundaries of the state.

Whereas Chapters 4 and 5 fleshed out the technological, institutional, social and governance dimensions of the composition of the CCS community, Chapter 6 attends to the important role of discourse, knowledge production and the policy dimensions of CCS. This chapter analyzes how CCS operates through narratives, rationalities, and scientific practices that help legitimate the deployment of carbon capture and storage. The second part of the chapter details the core barriers and challenges in the deployment and scale-up of CCS. The chapter shows that carbon capture and storage is maintained as a fix to the extent that storylines are successfully constructed both to construct a coherent case for CCS using rationales from science, engineering, and economics, as well as to build legitimacy in the larger public sphere.

Chapter 7 concludes the project by synthesizing the key empirical findings, and circles back to theoretical engagements that offer illuminating lenses through which to deepen and contextualize the empirical findings. To conclude, I consider how the meager progress of carbon capture in Alberta squares with two central contentions of the dissertation – that CCS serves as a political technology to produce new ways of managing complex issues, and that it serves as technological 'fix' that helps state and allied actors temporarily reconcile competing pressures related to the management of carbon. I discuss how the failures of CCS provide lessons not only with regard to the practical and pressing task of collectively mitigating climate change, but also

with respect to studying state-led projects at the political economy-technological interface. I also make the argument for a re-articulation of the relationship between technology and social dimensions, arguing that the prospects of carbon capture depend not on any specific characteristic of the technology, but rather on its larger mediating social context.

Chapter 2: Conceptual Foundations – Experts, Storylines and Fixes in a Techno-Bureaucratic Society

"The most important, difficult, and neglected questions of energy strategy are not mainly technical or economic but rather social and ethical."

- Amory Lovins

In this chapter I present the conceptual framework and central theoretical foundations upon which my dissertation is based. As outlined in the first chapter, this research produces a context-specific, detailed account of how hydrocarbon political economies, governance and state strategies, knowledge and expertise, intersect with the uncertainties of climate change to produce new ways of knowing and managing complex issues. In order to achieve this objective, I draw from four broad areas of literature – political economy, governmentality, actor-network theory and critical policy studies approaches - each of which elucidates the co-production of power and knowledge that is the target of my analysis. I briefly introduce each approach here, and then turn to a more detailed discussion of each as the chapter proceeds.

Political economy approaches examine the relationship between economic and political processes. Within geography, there is a strong political economy tradition, which examines the economy not as an isolated, self-functioning entity, but as fundamentally conditioned by politics and history. Most work in geography in this vein is based on the Marxist tradition of political economics, which is concerned with development and crises of capitalist societies, including not narrowly 'economic' issues, but also the politics of social policy, among many others. Political economy is used as a framework in this dissertation to understand why business actors and governments undertake particular strategies at the complex interface of economic and political processes with respect to climate change issues.

A governmentality approach can be seen as a broad theoretical lens adopted by scholars across a range of social science disciplines, rather than as a discrete field. This lens, based upon the work of Michel Foucault, is concerned with understanding modern power and rule as a question of the 'conduct of conduct,' namely those organized practices and techniques through which people are governed. It directs the researcher to the "how" of governing – that is, how rule is accomplished. I consider governmentality to be a sort of meta-theory that informs other methodological and theoretical approaches, such as actor-network theory and critical policy studies, which both seek to uncover how actors, discourses and objects circulate and transform in the process of accomplishing the governance of social formations.

Actor-network theory (ANT) asks "what work does 'science' do?" (Greenhalgh 2011: 339) by focusing on the total suite of actants (entities and actors) involved in scientific and technological enterprises, including scientists, Bunsen burners, blueprints, DNA, financiers, and fruit flies (Latour 1987, 2005). It can be considered a "material-semiotic" method (Law 2007: 2), tracing both the material (between things) and the semiotic (conceptual) networks formed by actors involved in technoscience.

Critical policy studies, part of which is included under the umbrella of a governmentality approach, investigates how policies come to form political subjectivities and regimes of government. This work emphasizes how actors compose and circulate the policies, standards and regulations that constitute key moments in the accomplishment of political rule.

It should be noted that an additional body of work contributes to this study. Key to understanding this case study in its specificity is engagement with the literature on environmental and natural resource regulation, in the particular context of Canada and Alberta. I discuss these literatures in Chapter 3, where they are discussed in close connection with the empirical context of the case study.

2.1 Technological Fixes and the Political Economy of Carbon Control

In the introduction, I stated that the complex problem of climate change has led many states to initiate what While, Jonas and Gibbs call measures of "carbon control." For them, this new era has led to a new "low-carbon polity," and the emergence of new "economic and political incentives for state strategies of carbon management" (2010: 76). It forms part of a larger 'eco-state restructuring' project that researchers need to take seriously because it is shaping institutional pathways of development at all scales.

It should be noted, however, that the pressure for states and other actors to *acknowledge* the need for 'carbon control' does not always translate into concrete *action*. While, Jonas and Gibbs explain the gap thusly: "[w]hilst eco-restructuring is premised on rethinking human impacts on the natural environment, it does not necessarily imply an unproblematic or necessary shift to some form of idealised 'eco state'" (2010: 77). This means that state and other actors may adopt rhetoric, policies, or actions to address climate change, but such undertakings do not mean that mitigation itself is a *fait accompli*. To be viewed as cooperative members of the international community, states and other major actors must proclaim support for and offer – indeed perform (see below) – an acknowledgment of climate change as a problem. Such acknowledgment can incentivize 'races to the top' and 'best practices,' or it can produce a cover for inaction or counter action, or many other points in between. Thus, in this dissertation I will refer to "addressing" climate change, to denote actors' acknowledgment of climate change as a problem, without assuming concomitant "climate correct actions" (Boykoff et al. 2009: 2309) have been undertaken and/or achieved.

Beyond the current consensus that anthropogenically-caused climate change is occurring, and that major actors need to 'address' it, there remain a several spaces of contestation within the context of state-led carbon control. The first is the relative share of mitigation to be taken on by particular jurisdictions. This is a question of distributional responsibility, which plays out as a

question of the *quantity* of emissions reductions to be carried out by parties, and remains a sticky point in international climate negotiations.[5]

The second space of debate pertains to the *quality* of emissions reductions – the means through which reductions are achieved (through fuel switching, conversion to renewables, reductions in demand, etc). This space of debate has seemingly followed from Marx's creed "from each according to his ability, to each according to his needs," as actors have tended to pursue mitigation approaches that build off of their own pre-existing advantages,[6] making mitigation choices that are generally politically or economically strategic. This highlights of the "strategic selectivity of the state" (Jessop 2002: 31): because capitalist states need to balance a complex of demands and goals – from security, to poverty alleviation, to environmental integrity to capital accumulation – they are strategically selective about the issues they pursue to maintain legitimacy and the right to rule (see Chapter 5). As such, states balance ecological goals with other demands and pressures, often selectively addressing environmental issues (While, Jonas and Gibbs 2010: 79, Krueger and Gibbs 2007). This has tended to produce a "patchwork of partially overlapping and sometimes contradictory laws, administrative rules, and programmes" (Meadowcroft 2005: 17) within a given temporal and spatial context.

Prior to their work on 'carbon control', While, Jonas and Gibbs (2004) introduced the concept of the "sustainability fix" to explain the strategic selectivity of the capitalist state with respect to ecological issues. The notion of a 'fix' derives from David Harvey's work on the temporalities and spatialities of capitalist social formations, and is one of several variants on the matter of ecology and capitalist tendencies in the social sciences.[7] Harvey argues that the existence of spatial or spatio-temporal 'fixes' are "forms of spatial reorganization and geographical expansion

[5] See Bumpus and Liverman (2008) for details about the role of allocation of responsibility among parties in international climate change agreement negotiations.
[6] Such as the move in the U.S. to tighten emissions regulations on coal, in the context of falling natural gas prices.
[7] See also O'Connor's work on the ecology and the second contradiction of capitalism (1988, 1991) and Castree's work on ecological fixes (Castree and Christophers 2015).

that serve to manage, at least for some time, crisis-tendencies inherent in accumulation" (Jessop 2004: 146, see Harvey 1981, 2001), holding, though not necessarily resolving, tensions between capital and labour, or between economic development and collective consumption (While, Jonas and Gibbs 2004: 551). Harvey designates two different types of fix: a more or less literal fix referring to the placement of capital in a geographically located, physical form; as well as "a more metaphorical 'fix,'" which refers to a temporary, contingently crafted solution to a specific crisis (Jessop 2004: 14, Harvey 2003a: 115, 2003b: 65-6). In this dissertation, we will come to see that while CCS might at first glance be considered a fix of the former type, the concrete outcomes of Alberta's carbon capture-focused carbon control strategy correspond more accurately to the latter.

Thus, based on Harvey's notion of the spatial fix, the `sustainability fix' is defined as the "selective incorporation of environmental goals, determined by the balance of pressures for and against environmental policy within and across" (While, Jonas and Gibbs 2004: 552). The concept is meant to capture some of the "governance dilemmas, compromises and opportunities" and to highlight the "search for a spatio-institutional fix to safeguard growth trajectories in the wake of ... the global `ecological crisis' and the rise of popular environmentalism" (*ibid.*: 551, see also Hajer 1995, O'Connor 1988). The concept does not disavow the possibility of the efficacy of a sustainability fix for ecological issues, but rather, "draws attention to the selective incorporation of ecological goals in the greening of urban governance" (*ibid*.). Indeed, Bumpus and Liverman suggest that fixes are not just played out as defensive strategies, arguing that "[c]orporations may therefore advocate emissions reductions both as a protection of their capital and as opportunities for profiting through lower carbon technologies and new offset markets" (2008: 131).

It is within this geographical political economic understanding of a 'fix', therefore, that I propose that carbon capture and storage should be viewed as a technological fix (see below for elaboration). Calling CCS a technological fix is to view it as both a physical fix (involving the placement of capital and physical infrastructure), as well as a metaphorical 'fix' that secures

discursive agreement, all within the context of securing growth trajectories in the face of public opposition.

2.1.1 Techno-fix or Technological Fix?

CCS technology has garnered attention as a so-called 'techno-fix' for climate change, but less is known about how a technological fix is actually enabled, requiring an investigation into how the technology is enrolled in processes of knowledge production, and in the regulation of spaces, processes and people. To designate carbon capture as such requires a distinction between how I define a technological fix, and how the idea of a 'techno-fix' is usually understood. While labeling something a 'techno-fix' is typically used as a dismissal couched within an explanation, designating something as a 'technological fix' begets the need to understand how and through what processes problems become *technicalized,* and to understand how social interventions *appear as technical solutions*. Put differently, the term 'techno-fix' closes the book, while the term 'technological fix' opens it up. The key difference between the two designations is that the former understands the topic of inquiry as a technological object, whereas the latter understands it as socio-technical process.

Typically, calling an intervention a 'techno-fix' is a way of dismissing it, usually because intervention is not considered to constitute a properly socially or politically qualified response to a problem. Some critics of CCS have dismissed it out of hand as a "political fig leaf" (Bennett 2011, see also Carter and Le Billon 2010), a "Faustian bargain" (Spreng, Marland and Weiberg 2007), or a "dead-end incremental technology" (Kemp and Rotmans 2005: 48) that papers over and justifies continued exploitation and expansion of fossil fuel development. In this reading, CCS amounts to an expensive, technological conspiracy that does not address the root social origins of the climate change problem. While this diagnosis of the *ends* might be true, the tendency in this dismissive use

of the term 'techno-fix' is to shuttle in a problematic assumption that the *means* through which such fixes are somehow also "only" technological. That is, this critical view of technological fixes tends to fetishize the technological component of the intervention, prematurely closing down analysis of the social processes necessary to use technology to solve problems in the first place. This closes down an analysis of the social life of technology, which I submit is precisely a moment of analysis that is required in order to understand how politics and climate change are mutually conditioned in the current age.

The techno-fix argument is illustrated by the work of Michael and Joyce Huesemann (2011).[8] The Huesemanns argue that optimism about the ability for technology to solve problems is misplaced, and as such, they question "a primary paradigm of our age: that advanced technology alone will extricate us from an ever-increasing load of social, environmental and economic ills" (2011: xxiii). But such a statement inhibits an analysis of the fundamental problem with technology fixes is. One of the problems with the techno-fix view of technology is that it remains atheoretical with respect to its object, technology, causing it to slip into the same technologically determinist lens that it critiques. The understanding of technology in 'techno-fix' critiques stands in contradiction to governmentality and science and technology studies (STS) views of technologies in further ways.

First, the techno-fix approach views the application of high technology as the insertion of an asocially produced object into an unrelated non-technical context. In STS, in contrast, there is little difference between context and content (Latour 1987: 159): science and engineering, but also economics and other technicalizing knowledge-producing processes (including policymaking), *produce* the social which is supposedly their context (Latour 2005, Latour 1991, Callon 1987).

[8] The book is self-described as a "classic critique of techno-optimism and the effects of modern technology on society and the environment," which has been praised by prominent thinkers such as William Rees, Richard Heinberg, David Suzuki, Vandana Shiva, Bill McKibben, Paul and Anne Erlich, and Herman Daly.

Haraway's rendition of the relation between technology and its putative 'others' articulates the difference between 'techno-fix' and technological fix that matters to this case. She argues,

> "[t]he technical and the political are like the abstract and the concrete, the foreground and the background, the text and the context, the subject and the object…. these are questions of pattern, not ontological difference. The terms pass into each other; they are shifting sedimentations of the one fundamental thing about the world – relationality" (2004: 237).

As such, Haraway enables me to argue that problems one might identify with carbon capture and storage technology will likely relate not only to the technical details of amine scrubbing on capture devices, or issues with storage formation pressure given the gaseous nature of carbon dioxide capture, but will likely also relate to the way carbon capture and storage technologies are positioned in policy documents, or to the way demonstration projects are funded.

The second key difference between the techno-fix and a socio-technical understanding of technology is the former's proposition that technologies are deployed as alternatives to, or stand in opposition to social struggles. In contrast, Latour has argued that technology is often an artifact of, a concretization of, social struggle and social action. By positing technology as 'society made durable' (1989), Latour offers a view of social relations where social action is 'delegated' to different 'actants' such as physical infrastructures and technologies that "are able to transport the action further through other modes of action, other types of forces altogether" (1989: 70).[9]

The third issue – ascribing a one-to-one relation of technology to a particular worldview (techno-optimism) – runs counter to the view of many scholars working within governmentality studies. These scholars point to a fundamental ambivalence between technology and politics,

[9] For instance, the turnstile at the subway station is delegated the action of inducing payment from transit users. Its semi-permanent welding to the transit station can be contrasted with another fare payment system that might consist of simply an attendant posted at the subway entrance to collect fares. The moment the attendant leaves their post, social norms of fare payment are likely to become unstable, and many users will avoid payment. The turnstile is, therefore, a social relation made durable.

arguing there is "no straightforward opposition…between the realm of technology, and the realm of politics" (Barry 2001: 10). For these scholars, the question of how politics and technologies are co-produced is an empirical one in each instance, to be reconstructed through in-depth studies of particular techno-political conjunctures. As Li argues, "[i]nterests are part of the machine, but they are not its master term" (2007: 9). John Law asserts that techno-scientific objects possess a 'fractional coherence,' as they are always "more than one but less than many" (2002: 3), articulated with particular paradigms but not equivalent to them.[10]

2.2 Thinkable, Sayable and Doable: Governmentality and the Political Technologies of Modern Power

In this section, I introduce governmentality approaches as a lens through which to see how carbon capture operates as a political technology that can enable actors to manage the complexities of the carbon crisis. In Chapter 1, I indicated that "carbon control" has become an increasingly central objective of governance at urban, national and international levels (While, Jonas and Gibbs 2010: 77). Thinking through climate change as an issue of carbon control enables a productive sort of strategic essentialism (Bridge 2011) – a framework for thinking through a complex socio-natural problem in terms of an 'elemental' problem. But carbon-centric thinking risks losing sight of one of the most valuable lessons of climate change: that it is a largely anthropogenic phenomenon. As such, framing climate change as an issue of 'carbon' risks obfuscating the fact that carbon control is always about regulating social practices – it is about managing people rather than molecules. It is from this perspective that it is possible to understand how CCS technology, as a carbon control technique, becomes enrolled in systems of governing social, economic, political and institutional

[10] Many technology scholars have demonstrated the multi-valency of technologies. For instance, just as the internet, invented by the US military (anathema to democracy for many), can become a symbol and tool of mass democratization, so can the drone be used either to exact new forms of ethically troubling killing outside the confines of traditional warfare, or as a useful tool for mapping in grassroots public research.

systems. The governmentality perspective takes as a starting point that governance is about governing the social context in which problems exist, as much as governing the problem itself.

If governance is always about managing social relations, it is necessary to understand how carbon capture and storage technology becomes enrolled in systems of governing social, economic, and political systems. This means understanding how CCS operates *beyond* the task of mitigating climate change, and to what ends (for what economic, political and institutional goals) (see Bouzarovski and Bassin 2011 for an equivalent approach to understanding pipelines and energy infrastructure). Using theoretical contributions from scholars working within governmentality frameworks, which are based on the work of Michel Foucault, this project is focused on how CCS technologies and policies "do the work" of (socio-)carbon control by working on and through social practices, institutions, policies, and the actions of agents (Mosse 2004, Li 2007). Such an investigative approach focuses on the conditions of possibility of the regulation of social practices: the rationales, forms of authority, and knowledge claims underlying regulation. It directs the investigator to attend to the socially mediated articulations between means and ends – how particular decisions, narratives, subjectivities and processes come to be attached to given policies and technologies (Dean 2010: 39), as well as the conditions under which such articulations emerge (Watts 2003: 14). By focusing on the 'how' of CCS and carbon control, attention can be paid not only to how climate change and carbon are governed, but also to how climate change and carbon are constituted *as governable*.

This means not asking of CCS simply "does it regulate anthropogenic climate change?" (instrumental evaluation) but also "*how* does it regulate climate change?" (through what instruments, discourses and articulations is carbon control accomplished). As critical development scholar David Mosse argues, the question is not *whether* projects and policies work, but *how* they work, and how success is produced (2004: 646). Thus, a governmentality lens lends analytical attention to productive and interpretive effects of policies and projects, and assumes that a carbon

control strategy based on CCS also produces a range of other effects in the world: it jostles with other mitigation strategies, like renewables portfolios; it might influence or be influenced by various publics, experts, or new combinations thereof; it might strengthen established knowledge regimes, regulatory regimes, and economic practices; or it might transform them (see Mosse 2004: 644-645, Li 1999: 374).

Work based on a governmentality framework also argues that, to make a claim on a field as manageable or governable, entails making claims about the truth of that field, and conditions its possibilities. To proclaim oneself as a 'trustee' of a field is to stake a claim of authority, and in the process to partially foreclose the claims of others (Escobar 1995, Mitchell 2002, Goldman 2006, Li 2007). This "will to govern" (Li 2007) is achieved through a myriad of strategies which Foucault called "political technologies" – devices and techniques that, along with associated types of "practical rationality" (expertise, knowledge and skills), are deployed under a "particular regime of practice" (a relatively coherent or institutionalized set of practices), in order to constitute a "regime of government" to shape the field of action of political subjects (Dean 2010: 21, 31, 33). It is through this analytical framework that one can account for the role of knowledge production in the mutual conditioning of climate change and the political.

Governmentality approaches see knowledge-production and the exercise of political action as distinct, yet highly articulated moments of practice that constitute how government is carried out in modern society (from the eighteenth century onward) (Foucault 2004: 219). A governmentality framework draws out the imbrications between knowledge and the exercise of power in the social field through its focus on the inherent link between authorship and authority. Seeing power and knowledge as a couplet is key in helping to specify how the power of carbon capture and storage technology lies as much in what is said about it, and by whom, as any particular technical merit it might have. A governmentality lens, "assumes that the ways in which we think about and represent reality are intimately linked to the ways in which it is acted upon and

governed" (Lövbrand 2011: 227). As such, it points to the need to examine the representations, scientific studies, economic models, and other forms of knowledge used in the process of developing knowledge about CCS as, at once, scientific and truthful, yet also partial and political.

To argue that discourses and the actors who use them produce truth effects is not to argue that the discourses are fabrications passed off as truth. It is rather an argument about truth in general terms, which is that all human endeavors to understand truth, being and reality suffer from an *inevitable gap* between 'what is' (the ontological) and how what is comes to be known (the epistemological). The goal, then, is to be able to assess how the *particular* forms and applications of knowledge used to inform the practices of governance help contribute to *particular* prescriptions for action.

My deployment of governmentality approaches show how CCS could become the method of choice for carbon control by viewing governance as an articulated and contingent arrangement of "what authorities want to happen, in relation to what problems and objectives, and through what tactics" (Watts 2003: 14). It opens up the black box of CCS, showing it not as just as a technology, but also as an instrument of government that operates through particular knowledge claims, rationalities, institutions, forms of authority, policies, decisions and actions of agents (Mosse 2004: 646, Li 2007). Above all, a governmentality approach to understanding CCS as carbon control requires attention to "apparently humble and mundane mechanisms which appear to make it possible to govern" (Rose and Miller 32); it sees that God (or the devil) is in the details.

Dean's (1999: 20-27) approach to governmentality, which sees the act of governing as an 'analytics of government', allows one to investigate the process by which government occurs, by delineating four dimensions to government. The first is "forms of visibility," consisting of the picturing and constituting of objects. For our purposes, this includes both the picturing and constituting of objects through the use of scientific inquiry, as well as practices of simplification and stabilization that make certain aspects of reality – certain complexities – *in*visible (see Chapter 6).

The second dimension of government is the episteme of government, which consists of "what forms of thought, knowledge, expertise, and calculation are employed in governing and how is form given to what is governable" (Watts 2003). Together with forms of visibility, it represents what Dean refers to as 'mentalities of rule' (1999: 32, see also Rose and Miller 2008: 6). The third dimension, the techne of government consists of "the means, mechanism, tactics, and technologies" through which "authority constituted and rule accomplished" (Watts 2003: 56). It refers to the techniques and practices undertaken to accomplish governance and constitutes what I refer to as "political technologies." The fourth dimension is forms of identification – "the forming of subjects, selves, agents, actors, in short the production of governable subjects" (Watts 2003: 56) relating to duties and obligations of subjects.[11]

While Dean delineates four dimensions of governmentality, Rose and Miller delineate two: (1) political rationalities or programmes, which are ways of representing and knowing, "rendering reality thinkable in such a way that it was amenable to calculation and programming" (2008: 16), and (2) political technologies, which are ways of acting or transforming (2008: 15). The former corresponds to Dean's mentalities of rule, while the latter corresponds to the techne of government (including forms of identification). For didactic purposes, one can roughly say that the former refers to knowledge that is used as a basis for action, whereas the latter refers to action based on knowledge. Rose and Miller insist that, "it is important to keep in view the irreducibility of each dimension to the other, at the same time as their often intimate and intricate interdependence" (2008: 20).

[11] Conceiving of the forms of identification in a case like CCS, as opposed to other issues that have been studied though the governmentality lens (like international development, welfare and psychotherapy) is less straightforward since it is designed to govern social relations around climate change precisely by *not* assigning to citizens the duty to manage their conduct for the project of carbon control, in contrast to many alternative carbon control measures (like rebates for home efficiency upgrades, electric vehicles, or investments in public transit or bike lanes). These imply a citizen subject whose behaviour becomes oriented towards self-government for the goal of minimizing their personal carbon 'footprint.' In the mainstream of CCS knowledge-production, exemplified in journals like the *International Journal of Greenhouse Gas Control* or the proceedings of the IEA-GHGT conferences, the duties of the public are typically formulated to "accept" CCS once sufficient rational information has been presented to them (e.g., Terwel et al. 2011).

I can now return to the question of how a governmentality approach can help us understand carbon capture and what can be thought, said and done about carbon. The governmentality approach emphasizes rationalities of government and sees science as "the core logic in modern systems of governance and power" (Greenhalgh 2008: 8). As such, one should expect that the advancement of a contemporary programme for carbon control would need to be based on the forms of visibility and epistemes derived from science. Governmentality scholars show that when science is used as the basis for a programme of intervention/action, it is done "by taking what is essentially a political problem, removing it from the realm of political discourse, and recasting it in the neutral language of science" (Dreyfus and Rabinow 1982: 196). This step occurs because, as Rose and Miller contend, "to presume to govern" requires the proposal of techniques to intervene (2008:15). The result is that, "[i]n short, to become governmental, thought had to become technical" (ibid). Thus, the first argument to take from governmentality studies is that interventions of government render problems of social rule technical (Li 2007).

The second point is a corollary of the first: that technicalization de-politicizes problems, despite their inherently political nature.[12] For Shore and Wright, "[p]olicies are most obviously political phenomena, yet it is a feature of policies that their political nature is disguised by the objective, neutral, legal-rational idioms in which they are portrayed" (1997: 8).

The third argument is that technicalization tends to channelize both forms of knowledge used to define the problems of government and actions pathways. This is because the intended outcome of government is an intervention, which requires a decision – the pursuit of one path that necessarily forecloses others. According Shore, Wright and Peró, then the task of the scholar

[12] To clarify, when speaking of "political problems," I am not referring to problems within the political sphere – a notion that presumes a discrete sphere for the exercise of order over human communities. Rather I contend that all matters that need to be dealt with (problems) are inherently political, whereby political refers to a matter subject to decision from the 'polis,' from citizenry, which is characterized by plurality (the possibility of multiple paths), and therefore dissensus (Rancière 2011). As such, all problems are 'political' because they all require decision in the context of multiple possible pathways, and therefore multiple possible decisions.

becomes assessing how are "normative claims used to present a particular way of defining a problem and its solution, as if these were the only ones possible" (2011: 1).

Fourth, one can now see that the products of knowledge have a legitimating function when they are incorporated into the activities of governance, including policymaking. To Rose and Miller, not only do programmes of government "outline the course of action to be taken, they also serve to fix that course within the framework of a wider and more universal set of goals and principles. This works to lend further 'authority' to the decisions taken. It also functions to rule out disagreement" (2008: 11).

Through this formulation, then, technicalization/depoliticization, legitimation and channelizing are all closely articulated, and are furthermore articulated with a fifth and final point, which is that all analytics of government "inevitably contain implicit and sometimes explicit models of society" (Shore and Wright 1997: 7). That is, discourses about a particular aspect of reality, including those produced by science, and all modes of action prescribed by such discourses in order to explain or intervene in the world, contain a vision of reality, one that is inherently normative and partial.[13]

If it follows that political technologies have a legitimating function (fourth point), and that they also contain explicit models of society (fifth point), and that the authors of programmes of government tend to frame governance problems in such a manner that the author of the intervention is also the authority on the matter (above), then it stands to reason that political technologies often serve to legitimize a particular vision of society that conforms to the interests of the author(ity).

As such, Foucault argues, political technologies, such as policies, operate as 'truth regimes' (Wilson 2000). What does this mean? Foucault indicates with the term "regime of truth," that

[13] For instance, Dorothy Smith's work on adoption and same-sex couples has shown how bureaucracy documents embed a particular vision of "normative 'ruling relations,'" whereby within and behind apparently neutral, impersonal language and rationalities of bureau texts, is concealed a "male subtext" (2005: 13).

"truth" is constituted by "the production, regulation, distribution, circulation and functioning of statements," through an ordered system of procedures (Foucault 1977; see also Lorenzini 2013). As Lorenzini (2013) emphasizes, critical to Foucault's concept of truth and its production, are its links to "a circular relation to systems of power which produce it and sustain it."

2.3 Critical Policy Studies: "Storylines" and Mobile, Mutable Policies

With respect to policies in particular, one can say that they operate as truth regimes (Bockman and Eyal 2002: 313) because they consist of a procedure that aligns a description of a problem in the world with a set of proposed interventions, rationales for intervention, authorized means of intervention, as well as a set of actors designated to both diagnose and intervene. For Peck, the production of policy truths is recursive: he contends that paradigms have "their own social ontologies" that affect the "very nature of the problems they are meant to be addressing" (2011: 12). Furthermore, policy paradigms and their constitutive discourses, diagrams and quantified figures are powerful because actors "think *with* them" (Peck 2011*:* 12). Specifically, they are powerful because *other* actors think with them. Kuus makes similar claims in her investigations of the EU's political power, finding that the EU is a powerful political entity in part because its knowledge is utilized by other actors (2011b).

Work by Bockman and Eyal, Peck, and Kuus forms part of critical policy studies, an area of inquiry that also informs my consideration of the governance aspects of CCS. Critical policy studies is an interdisciplinary scholarship, some of which is situated in a governmentality perspective that investigates how policies come to form political subjectivities and regimes of government (Shore and Wright 1997, Peck and Theodore 2010, Shore, Wright and Peró 2011). Critical policy studies offers valuable theoretical and methodological tools for understanding how CCS operates as a political technology by informing an analysis of how actors compose and circulate the policies,

standards and regulations that constitute key moments in the production of carbon capture as a new form of carbon control.

Scholars working within this subfield see policies as ubiquitous political technologies of rule, "dominant form[s] of regulation of social conflicts in modern industrial societies" (Hajer 1995: 22), and argue that "an understanding of the politics of these policies … is thus central" (Greenhalgh 2011: 7,8; see also Shore and Wright 1997, Shore, Wright and Peró 2011). Yet despite the powerful role of policymaking, it is a process often "without a central author or coordinating agency" emerging "from the 'spaces in between' agencies," whose form, process and outcome often escape "even …those intimately involved" (Feldman 2011: 28). It is also still largely a process understudied by social sciences like anthropology, geography and sociology (Wright and Shore 1997).

Critical policy studies focuses on the productive power of policies, arguing that "[p]olicies do not merely regulate existing relationships; they create new relationships, objects of analysis, and frameworks of meaning" (Kuus 2014: 39, see also Shore and Wright 2011: 1). It also focuses on the production process of policies, seeing policies as the result of "lengthy processes of drafting, consultation, and negotiation" (*ibid.*) rather than pre-formed, clear-cut political mandates.

Several scholars working within the subfield combine the insights of governmentality and actor-network theory, calling for attention to be paid to the work science does with policy (Greenhalgh 2008: 307). Anthropologist Susan Greenhalgh offers a productive approach in her work on "scientific policy-making" (2008: xv). Using China's 'One Child' policy and its techno-scientific underpinnings as her case study, Greenhalgh's project is to combine insights from governmentality approaches, which highlight "the fundamental role of knowledges… in the making of the political," with science and technology studies (STS), which "highlights the political nature of knowledge making" (*ibid.*: 6), in order to apprehend the "porous boundary between science and politics" (*ibid.*) and the coproduction of public policy by political and scientific elites. Greenhalgh's

approach allows the researcher to extend the insights STS has made about following scientists to the lab (see Latour 1987), and follow them "to the office" (2008: xv).

Greenhalgh's work demonstrates that scientists and members of scientific communities are often not merely advisors to policymakers, but can themselves become policymakers. That is, due to "their status as authoritative knowledge producers," scientists (including natural scientists, engineers, as well as social scientists) are frequently "active participants" in the creation of policy (2008: 8). In Chapters 4, 5, and 6, I will show that this was the case with scientists and other experts in developing carbon capture in Alberta.

Greenhalgh proposes employing an epistemic (knowledge-centered) approach to studying the science-policy interface. This approach gives weight to how institutions think, how states see, and how laws know – and, as such, its central concern is "how regimes reason" (2008: xv). For Greenhalgh, "questions of origins" are of "greatest importance" (2008: 308), and her approach gives analytical attention to the contingency and specificity of a particular geographical and political milieu of actors and institutions (2008: 9). In this way, employing an epistemic approach offers an antidote to existing analyses of CCS communities (discussed below), which tend to be ahistorical, and not fine-grained enough to trace the specificities and contingencies that helped shape both the international and Alberta CCS communities today.

For Kuus, the attention to knowledge practices highlighted in critical policy studies requires "that we untangle the intellectual and social technologies" through which different aspects of realities are brought together into knowledge claims (2011a: 275). Discourses – the ways in which social processes are imagined, written about, and talked about – are fundamental intellectual and social technologies. For carbon capture, its conditions of possibility for regulating carbon are shaped by, and preceded by, discourses, narratives and 'storylines' about it.

Discourses, by providing condensed explanations of aspects of reality that can then be shared and circulated amongst actors, form a key component of governance and policy. If

discourses consist of what is thought and said, and policies delimit what can be done, Lövbrand contends that, "in order to understand what is thought, said and done, it is necessary to identify and describe the knowledge practices that make these things thinkable, sayable and doable" (2011: 227; see also Miller and Rose, 2008: 3; Lövbrand et al., 2009). As such, discourses can be seen as key components of political technologies. Applerouth and Edles argue as much when they suggest, "in modern, Western societies, social domination operates through texts (such as medical records, census reports, psychiatric evaluations, employment files) that facilitate social control" (2011: 321). Rose and Miller also argue that governing has a discursive character (2008: 29-32), and that discourse should be seen as a "technology of thought," which involves varied and multiple ways of knowing an object through "procedures of inscription" (2008: 30).

For them, crucially, it is in discourse that a "consonance" is established between "broadly specified ethical, epistemological, and ontological appeals of political discourse" and "the plans, schemes and objectives that seek to address specific problematizations" (2008: 31). It is at the discursive level that widely held, if not competing social political imperatives – the need to address climate change, the need to grow the economy, the need to support innovation – are articulated with specific "problematizations," or means to address these imperatives. For example, in their study of energy infrastructures in Eastern Europe, Bouzarovski and Bassin highlighted the different ways in which the development of networked energy infrastructures has been contingent on the articulation of political narratives with particular socio-technical projects (2011: 785). As a result of the 'textual' forms that modern governance takes, Rose and Miller advocate for attention to discourse and language, not simply in terms of meaning or rhetoric, but also "as intellectual technologies' that render aspects of existence amenable to inscription and calculation" (2008: 31). For them it is within political discourse that a more or less systematic field of intelligibility is created through which particular "truth claims" are structured: discourse represents what is

'sayable' within an analytics of government, which in turns makes intelligible a particular constellation of what is thinkable and doable through a political technology.

In turn, policies act as authorizations of what is thinkable and doable - ways in which actors can intervene in the world – articulated through the discursive mode. According to Rose and Miller, governing is never just a particular way of representing problems, but also a complex of representation and *intervention* (2008: 32). Technologies of government such as policies, they contend, "seek to translate thought into the domain of reality, and to establish 'in the world of persons and things' spaces and devices for acting upon those entities of which they dream and scheme" (Rose and Miller 2008: 32).[14]

Some core activities of modern societies – science and engineering, economics, governance, policymaking – all of which are instrumental in the development of carbon capture – are not just actions in the world, they are also discursive endeavors. Actor-network theory scholars have shown this to be true about science and engineering (Latour 1987) and economics (Callon 2006), and social theorists such as Laclau and associated scholars (Laclau and Mouffe 1985, Laclau 2005, Torfing 1999, 2005), have similarly analyzed political and governance activities as discursive processes.

Maarten Hajer's 'environmental discourse analysis' (EDA) framework is particularly useful, because this approach elucidates how policies operate in the discursive mode. According to Hajer, policy has been the central "socially accepted set of practices" through which ecological crises have come to be dealt with, and as such, deserving of analytical attention (1995: 2). To Hajer, the primary aim of environmental discourse analysis is to discover why particular understandings/framings of 'environmental problematiques' gain dominance over others (1995: 44).

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[14] For instance, Lovell and Liverman (2010) examined how the Clean Development Mechanism for climate change mitigation compliance helped to create offsets. To create carbon dioxide (and equivalents) as tradable units requires not only the development of the representational space to imagine carbon dioxide in such a way, but also a complex of calculation, measurement and verification schema to make it possible to act upon greenhouse gas emissions in such a way as to make them tradable, and to trade them.

For Hajer, the first task of the researcher, *pace* Greenhalgh's idea of how regimes reason, is to ask: "How do problems get defined and what sort of political consequences does this have?" (1995: 2). Thus, the focus is not how problems such as climate change, acid rain, deforestation etc. get solved, but rather, how they are discursively constructed as problems. Policymaking, then, is less a process of problem-solving than a process of 'problem-construction,' where "problems also have to be devised to be able to create policies" (Hajer 1995: 15) in such a way as to make them amenable to solution via policy-making (see also Hall 1993: 279; Peck 2011: 12).

This means that policy-making bodies generally frame socio-environmental problems in such a way that they are the appropriate agent to cope with said phenomenon, and that the method adopted by the agency is the most appropriate course of action. For example, Alberta's 2008 climate change strategy is not simply a climate change document. For the Government of Alberta to have a climate change policy, it must first frame climate change as a problem in need of solving (which is significant in itself, since it is not a universally shared sentiment amongst Alberta's elected representatives). Next, it requires framing the Alberta government as the most appropriate body for addressing climate change (as opposed to, for example, the federal government, the UNFCC, or individuals). Finally, the *Strategy* was constructed in such a way that carbon capture was not the best solution to Alberta's climate profile.

That policymaking entails the (re)definition of problems highlights that environmental problems "should not be conceptualized as a conflict over a predefined unequivocal problem…, but is to be seen as a complex and continuous struggle over the definition and the meaning of the environmental problem itself" (Hajer 1995: 14). A few implications follow from this argument. First, it suggests that attention needs to be paid to the arena of struggle between actors - to the contexts in which discourses operate and circulate, since these have determining effects on discursive outcomes (Hajer 2005: 302; Hajer 1995: 2). As such, discourse analysis should consist

not only of an examination of uttered statements (written or spoken), but also of the practices, forums and mediums in which statements are made (Hajer 1995: 299).

Secondly, it suggests that a necessary element of discourse analysis is an understanding that policy discourses about a particular environmental problem also construct a particular arrangement of the 'proper place' of associated subjects and objects around the problem, embedding a particular vision of "normative 'ruling relations'" within the policy (Smith 2005) (explored with reference to carbon capture and storage in Chapter 6).

Third, such a view of policy discourses enables one to see that dominant, or consensus, discourses about environmental problems are contingent, unstable, and tend to 'suture' divergent but overlapping discourses more so than representing monolithic sets of rationalities and interests. A central concept in EDA, the *storyline*, captures this third implication. A storyline refers to a condensed narrative of social reality that "provide[s] actors with a set of symbolic references that suggest a common understanding" (Hajer 1995: 62, see also Hajer 2005: 302). The storyline functions by referencing one specific element of the issue, which then "effectively reinvokes the storyline as a whole" (1995: 62). For example, "acid rain," as an element of the story of negative environmental outcomes of the release of sulfur dioxide and nitrogen dioxide from industry processes into the atmosphere, comes to invoke the story as a whole. The key function of storylines is to suggest a sense of unity in diverse components of an environmental problem, and/or as condensations of key legitimizing arguments.

The storyline of sustainability, as explained by Swyngedouw, serves as an illustration. Observing support for sustainability, he contends, "Greenpeace is in favor, George Bush Jr. and Sr., the World Bank and its chairman… are, the Pope is, my son Arno is, the rubber tappers in the Brazilian Amazon forest are, Bill Gates is, the labor unions are" (2007: 1). All the actors he lists are in favour of sustainability, yet as Hajer argues, each party can "speak about [sustainability] but mean (slightly) different things" (1995: 13). An important consequence of such multi-valency is

that, although each of these actors has differing social and cognitive commitments, they nonetheless sustain a storyline that begins to generate its own social effects (*ibid*.). Thus, actors within a discourse coalition may have differing commitments or understandings, but "nevertheless together produce meaningful political interventions" (Hajer 2005: 302). The storyline concept is used in Chapter 6 in order to account for the production and circulation of legitimizing narratives for CCS in the scientific and policy spheres.

Other scholars have also suggested that policies can be analyzed as narrative forms (McCann 2013, Jessop 1997, 1998, Jessop and Sum 2000). In the context of urbanism, Temenos and McCann, for instance, discuss how the management of municipal governance problems and solutions through policymaking requires the "deployment of persuasive narratives" (2012: 1401). This includes stakeholder interfaces (structured forms of participatory planning), as well as "chosen and constructed indicators, benchmarks, metrics, and so on" (*ibid*.). Indeed, McCann argues that figures, maps, charts and tables – 'inscription devices' (Latour 1987) - act as "narrative evidence" that underwrites the need for, and justification for, many technological state projects. Yet as Temenos and McCann suggest, these devices are always "chosen and constructed" to present supportive, not countervailing, evidence for the particular policy path being put forward (2012: 1401).

For McCann, the task of the researcher is to uncover the mechanisms and processes by which *ideas* contained in a given policy narrative come to intersect and become imbricated with particular *political forms* (2013). Echoing Hajer's contention that policy narrative elements matter because they are capable of producing political interventions, Temenos and McCann contend that the policy narratives they studied allowed "local businesses to integrate existing corporate practices into municipal policy and to define and legitimate a specific version of sustainability and success" (2012: 1401).

The geographically focused subset of critical policy studies also looks at 'policy mobilities,' investigating "how policy actors circulate policies… how they draw on circulating policy knowledge, and how and for whom they put these engagements to use" (McCann and Ward 2012: 43, see Peck and Theodore 2010). Such an approach stands in contrast to more 'orthodox' policy studies approaches that view the transmission of policy and regulatory models as one of 'transfer-diffusion,' a unidirectional process of sequential diffusion from 'innovator-pioneers' to 'emulator-adopters' (Peck 2011). This work takes a process-centred and relational approach to policy, seeing policies as "relational constructions" that "through their very movement they (re)make connections between these sites, evolving in form and effect as they go" (Peck and Theodore 2011: 4).

By following the policy closely, policy mobilities scholars argue, researchers will begin to see policies not as rational vectors, but as "mutating and contradictory policy networks" (Peck and Theodore 2012: 2). Mutation denotes the idea that policies travel as multiple intersecting, sometimes reciprocal, pathways: even policies that are putatively the "same" will produce different effects in each place, "by virtue of their … interactions with, local economic, social, and institutional environments" (2010: 173).

Overall, critical policy studies offers a valuable framework to this dissertation by informing an analysis of how actors composed the policies, standards and regulations that enabled carbon capture to become (for a time) the central form of carbon control in Alberta, and by showing how policy paradigms and their constitutive discourses, diagrams and quantified figures are powerful because actors think with them.

2.3.1 Traveling Technocrats, Bureaucratic Intellectuals, Legitimation, and Intellectual Path Dependencies

Geographically sensitive critical policy studies attend to the mobility of not only policies, but also policy-makers, highlighting the role of actors and agency in policy processes (McCann and Ward 2012: 43). Much of the research focuses on "traveling technocrats" (Larner and Laurie 2010) whose beliefs and actions are understood to be embedded in both wider networks of knowledge and experts, as well as within more 'localized' milieux (Peck and Theodore 2011: 3-4). Policy mobilities research therefore traces the complex sociality of policies (Larner and Laurie 2010: 224), the way they often entail the intersections of various "social worlds" (Theodore and Peck 2011), even as they entail their production and reconfiguring.

Larner and Laurie's work on 'traveling technocrats' shows that attending to the mobility of policies and knowledge necessitates also following the policy-makers and others who carry knowledge in mind and briefcase. If, as Dezalay and Garth have shown, "learned practitioners play a major role in international transformation" (2002: 8), then it is necessary to highlight the role of actors and agency in the advancement of new ideas and technologies (Ward and McCann 2012: 43). The notion of the traveling technocrat enables one to trace the complex sociality of policies, and the way they often entail the intersections of various "social worlds" (Theodore and Peck 2011). This is certainly the case in Alberta, where the CCS "community" is an intersection of the social worlds of the energy industry, federal and provincial bureaucracies, researchers and academics, and NGOs, many of whom operate as much across any jurisdictional boundaries as within them.

In previous sections, I articulated that a key to understanding how contemporary governance operates is to assess how particular interventions in the world as made thinkable, sayable and doable. As Kuus suggests, scholars need "to know why and how knowledge counts and fails" (2011: 1). And thus it stands to reason that if some discourses about the technology tend to

"count" more than others (Chapters 4 and 5), and some discourses count certain aspects of reality at the expense of others (Chapter 6), then one needs to establish *who* is counting. According to Kuus, intellectual and political technologies "establish the analytical terrain of particular methods and agents deemed appropriate to deal with [fields]" (2011a: 2). In this sub-section, I review some of the ways in which we might conceive of the actors who think, say and do, that adequately reflects the crucial role they play in the trajectory of the development of CCS as a carbon control strategy.

The work of Kuus (2011a/b) and others (Mitchell 2002, Neumann 2012, Greenhalgh 2008) has shown that an understanding of bureaucratic processes is key to understanding the bigger, 'sexier' geopolitical issues they generate. If contemporary political power relies upon the progressive composition of a bureaucratic undergirding, it also relies on the legitimizing authority granted to state policies and decision-making processes by various forms of expertise (located at various degrees of distance from the state). For these scholars, to follow modern power closely, the work of the researcher becomes one of accounting for discourses and practices through which grand geopolitical issues are produced rather than the more mundane daily practices of bureaucracies, technical bodies and liaised experts (Kuus 2011b: 422). This requires seeing geopolitics as a bureaucratic and material practice, obtaining detailed accounts of bureaucratic settings, and situating these settings in their place-specific context (Kuus 2011b), in order to ask through "what instruments, procedures, techniques and vocabularies is expert authority accomplished," including expertise itself as a political technology (Kuus 2011a; see also Miller and Rose 2008: 21).

As such, it is possible to investigate key moments in the development of carbon capture in Alberta as social processes through which technical expertise and judgment become authoritative. This process is particularly salient in cases where 'matters of concern' are relatively novel, like new technologies, whose costs, impacts and effects are not well known (Callon, Lascoumes, and Barthes 2009), or when the matter of concern is a complex 'wicked problem' (Levin et al. 2012), like climate

change. With new or complex matters of concern, the work of experts is required to narrow the field of uncertainty, structure action, and frame what is included and excluded as relevant to an issue. Kuus notes that experts "make particular arguments coagulate as legitimate expertise" (Kuus 2014: 40; see also Miller and Rose 1990: 5; Mitchell 2002), but also contends that political and social dynamics operate within the "technical argumentation" of expertise (*ibid.*; see also Greenhalgh 2008:16). This signals expertise both as a "social credibility contest" (*ibid.*) and as an inherently partial vision of the world as it is and could be.

Given the role of expertise in shaping social responses to matters of concern, Kuus argues that, "[w]e must understand the technologies of expertise that … ultimately render social reality codifiable and manageable" (Kuus 2011b: 422). That is, it is necessary to understand the ways that experts and their expertise enable actors to intervene, to "act in a uncertain world" (Callon Lascoumes, and Barthes 2009). Seen this way, technologies of expertise, including the integration of diverse forms of expertise, enable the progressive, appropriate 'problematization' of problems in the form of 'gelling' of discrete issues, domains, and objects into a coherent material/discursive response (Kuus 2011b: 422).

This opens up the larger question of what, exactly, constitutes expertise. While it might appear that expertise is a 'thing' that experts are in possession of, some scholars view expertise "not [as] a thing but a social relation" (Kuus 2011: 277). That is to say, while a peer reviewed paper, a database, or an experimental synopsis can be sent from one party to another, expertise cannot be shipped from a building at Carnegie Mellon University to a conference room in downtown Edmonton. Instead, expertise is inextricably linked a) to the expert herself, but crucially, also b) to the expert and the social field in which her expertise is recognized as such. That expertise is inextricably linked to the expert means that it is embodied: the successful operation of expertise is in many ways linked to the physicality of the expert. Furthermore, since it is constituted in the relational social field, expertise can be conceived of as both dynamic and performative. For Kuus,

the authority of expertise functions only when "it is accepted by both sides" (*ibid.*), and consists of a practice manifest through action, utterance, gesture and so forth. It is, therefore, "not something that one has but something that one uses or performs" (*ibid.*).

Context and geography matter too, in terms of the sociological origin and exchange points of the expert claims that underpin many policies (Peck 2011). Both Kuus and Peck, therefore, demonstrate that there is a political geography to expertise, underscoring Agnew's contention that, "*where* knowledge is produced and where it circulates is integral to its effects" (2007: 2). For example, the claims of a German or Italian soccer coach might bear more weight on a discussion of World Cup soccer than those of a Canadian or Mongolian coach. That is, the "know-where" of the claim matters (Agnew 2007), and as such, calls for the need to "examine technologies of expertise spatially" (Kuus 2011a: 285).

While this *where* is at times geographical, it can also be about the social milieux in which narratives develop and gain validity. For instance, Bouzarovski and Bassin (2011) link the construction of policy and technology narratives to the circulatory social arenas through which they expand, and Aalto has suggested that "discourses can become translated into relatively coherent and stable policies when they become empowered, i.e. invested with an adequate resource base and social resonance" (2002: 152).[15]

Thus, the social milieu of experts and scientists, within the political economy milieu, provides the context in which the transfers between scientific knowledge and policy knowledge occur. Below, I present Latour's contention that science can only happen through the "massive transfer of interest" from scientists to the representatives of industry and government. Arguably, Latour does not adequately discuss whether there is any transfer of interest back to scientists. However, work by Lövbrand (2011) and Barry and Weszkainys (2008) on "useful" science shows

[15] Indeed, the legitimacy conferred to CCS as a mitigation technology after 2005 can be attributed to the authoritative social arena – the Intergovernmental Panel on Climate Change – which it successfully circulated through. The IPCC began to "think *with*" CCS, and other actors followed suit (see Chapter 6).

that government agendas *do* play into the funding of research. And, as it turns out, their work brings me full circle back to not only the political economic perspective, but moreover, to a way in which political economic and governmentality perspectives connect.

Lövbrand's piece followed from Merton's on 'the bureaucratic intellectual.' In the 1940s, sociologist Robert Merton outlined the pitfalls that can arise when scholars are asked to contribute to policies already formulated by 'governmental bureaucracies" (1945; see also Lövbrand 2011: 226). His central claim was that "[i]f the intellectual is to play an effective role in putting his knowledge to work, it is increasingly necessary that he become a part of a bureaucratic power structure" (Merton, 1945: 411). Merton drew out a tension between the freedom available to the 'unattached intellectual,' and the curtailing of this in order to ensure resources "and any strong likelihood of having his findings accepted by policy-makers as a basis for action" (*ibid*.).[16]

The bureaucratic intellectual is that figure who, when asked to provide information for policies that are already formulated by policy-makers, "has to refrain from the full opportunity of choice" (Lövbrand 2011: 226). Instead, the researcher whose agenda has been tethered to the applied problems of government has to "think in technical and instrumental terms of ways of implementing a policy *within a given situation"* (Merton 1945: 412), in the process limiting the act of problematization to the horizons dictated by the expediencies of policy.

Using Merton's work, Lövbrand examined a case of "useful science," an EU integrated research project ADAM (Adaptation and Mitigation Strategies: Supporting European Climate Policy), where scholars worked alongside policymakers to produce new climate policy. Lövbrand found that, rather than acting as a site for "policy re-examination and learning," scholars' efforts were consistently being channelized into "restricted … interpretations of useful knowledge" set by policymakers (2011: 234). The case highlighted the politics of useful knowledge: in order to be

[16] In many ways, Merton's formulation on this account prefigures Latour's notion of science in action as the reshuffling of the interests of allies.

useful, ADAM researchers acted as "scientific support of existing goals" (2011: 232), rather than challenging or refashioning existing policy goals. The case illuminated the fact that science enrolled directly into policy formations did "more than simply legitimate existing power relations"; science also served a "constitutive function," helping to render to objects of knowledge (in this case climate change) "as something governable" (2011: 233) in the first place. This circles back to Hajer's contention that policy problems are formulated in such a way as to render the policymaker the most appropriate agent to manage the problem.

It also brings me to argue that, in the case of carbon capture, since the technology is promoted by a community of actors to the extent that these actors believe it supports their goals, CCS enables a continuation of what scholars call "path dependency." Taken from evolutionary economics, path dependency refers to a "process or system… whose outcome evolves as a consequence of the process's or system's own history" (Martin and Sunley 2006: 399). Path dependence approaches underscore the conditioning role that "institutional legacies and continuities" play in shaping responses to crises, and economic transformations (Pavlínek 2003: 94), and in short recognize that 'history matters' to political economy. The concept has been taken up by economic geographers to account for place-based differences in economic trajectories, since present conditions alone cannot fully account for the geographical diversity of economic conditions.[17] In this study, path dependency operates both at the political economic level in terms of dependency on fossil fuel exploitation (Chapter 3), but also on the level of knowledge-production. In Chapters 4 and 5, I will show how Alberta's climate change strategy was influenced by the expert domains and career trajectories of experts, bureaucrats, and others involved in carbon capture and storage technology.

[17] However, there is a difference between path dependency and past dependency. Path dependency does not represent a hard historical determinism, but rather recognizes that economic change in a particular region results from "a combination of path dependent constraints and path shaping transformation strategies" (Pavlínek 2003: 95).

2.3.2 Existing Characterization of the Carbon Capture and Storage Community

The previous sub-section outlined ways in which we might understand the social dynamics and actors involved in deploying CCS, but what do existing characterizations offer? Existing literature on CCS, including early studies on the subject, has been largely dominated by engineering-focused work (Shackley and Gough 2006). Bäckstrand, Meadowcroft and Oppenheimer argue that, as a result, there is a substantial body of literature on CCS covering its technical and economic aspects, but less on the social values and social perceptions of the technology (2011: 275-6; see also Stephens et al. 2011: 276). However, a small but growing empirically focused body of literature on the social dynamics of CCS has begun to emerge (see special issue of *Global Environmental Change* 2011 (issue 21)). In one of the first edited monographs on CCS, *Caching the Carbon* (2010), Meadowcroft and Langhelle attempted to grasp why and how CCS rose to prominence relatively rapidly as a legitimate carbon mitigation option in some countries. Others have noted how a community of actors advocating for CCS "has been influential in lobbying for increased support for the development of carbon capture in many countries and at the international level" (Stephens et al. 2011: 379), and has resulted in a rapid growth in the number of individuals and agencies working to advance carbon capture (Climate Group, Ecofin, and Global CCS Institute 2010, Tjernshaugen, 2008).[18]

Newer social science research on CCS has begun to characterize and analyze the social and institutional arrangements that have made the ascendency of CCS as a climate change mitigation strategy possible. In their 2012 edited volume, *The Social Dynamics of Carbon Capture and Storage* (2012), Markusson, Shackley, and Evar attempt to account both for the success and promise of CCS, as well as how prospects began to fade at the turn of the decade.

[18] Which, in Canada, has translated into programs and initiatives to train 'highly qualified professsionals' (HQPs) in CCS specializations (Interviewees I35, I32).

One Canadian characterization is worth noting. Campanella (2011) employs a political economic approach to understanding carbon capture in Alberta, finding that "[t]he research agenda for CCS has always been directed by the fossil fuel industries and governments heavily-invested in fossil extraction industries" (2011: 5). Campanella's work trains a close eye on the activities of engineers, researchers, and the scientific community in the development of CCS in Alberta, observing that commercial and government interests strongly influence the activities of some scientists and engineers. However, devoting more attention to the activities of scientists and researchers than most analyses of CCS, Campanella seems to conclude *a priori* that all research and scientific activities related to CCS are exclusively subsumed under, or directly controlled by fossil fuel interests alone. Campanella ascribes all of the power of science to forces outside of science, such that it is merely an instrument of capitalism, rather than a series of practices, which are articulated with it. His analysis would seem to imply that science ought to instead operate in an unsullied silo, a view which ignores both the history of science and engineering, as well as the fact that "[s]cience is fundamental to modern governance and its policy instruments" (Greenhalgh 2008: xiv). Nevertheless, it is through a political economic lens that it is possible to see that CCS developed as a technological fix, a possibility afforded by an already established close relationship between industry, government and research bodies.

Other analyses of CCS communities employ a national-level analytical frame (de Coninck and Bäckstrand 2011, Jaccard and Tu 2011, Román 2011, also Stephens et al. 2011). Stephens and Liu characterized the world CCS community, conceiving of the actors involved in CCS as a coherent international CCS community, consisting of "all academics, policymakers, regulators, researchers, engineers and other professionals both from public and private sectors who have a central focus of their work on CCS" (2012: 131).

While Stephen and Liu's analysis offers a useful starting point for characterizing carbon capture communities, their national-scale analysis suffers from a number of shortcomings. First of

all, these analyses are largely ahistorical, and do not account for how international and national carbon capture communities came to be constituted as such; these analyses overlook the strong interconnections between carbon capture communities and antecedent hydrocarbon communities (explored in Chapter 4). Second, in using national-scale analysis, actors' activities are postulated as occurring in discrete national communities nested in a single, larger international community. As such, one of the most notable features of carbon capture communities - the relatively high degree of inter-jurisdictional cooperation (explored in Chapter 5) – is missed. This means that various socio-institutional geographies that constitute, rather than sit within, a 'national' or 'international' context for carbon capture are hidden, rather than revealed.

Stephens et al.'s 2011 analysis of CCS actors analyzed these actors as an epistemic community. The epistemic community approach foregrounds expertise/professionals and the policy-making context. Epistemic communities, according to Antoniades, are ''thought communities made up of socially recognized knowledge-based networks, the members of which share a common understanding of a particular problem/issue or a common worldview and seek to translate their beliefs into dominant social discourse and social practice'' (2003: 26).

For Miller and Fox, knowledge-building, "depends on the background and interests of the epistemic community that is generating knowledge" (2001: 668), suggesting at once that the object of knowledge, and the accepted standard of validity surrounding inquiry of the object of knowledge, are specific to that community. Community norms and practices "both enable and delimit what is feasible and worth striving for" (*ibid.*), suggesting that if each epistemic community is about generating truths about the world, it is also involved in adjudicating what aspects of reality should be subject to intervention, whether they can be subject to intervention, and through what means. If, in each epistemic community there is an implicit counting and discounting of aspects of reality – valorizing particular dimensions of reality as most important for policy action – then there are three consequences, which I discuss in turn.

Firstly, any reductionist, essentialist, or non-critical disciplinary 'blinders' (simplifications) of the community may be amplified, rather than attenuated within the community itself. Stephens et al. (2011) point to previous energy technology studies, that recognized that experts "tend to exhibit overconfidence about and a positive bias towards the particular technology they are working on" (2011: 280; see Hultman and Koomey, 2007), and more generally, focusing "on factors promoting success," at the expense of pessimistic scenarios (*ibid*., Buehler et al. 2005). They point to previous research on CCS actors that has empirically demonstrated over-optimistic evaluations of the technology by CCS researchers (Malone, Dooley and Bradbury 2010; Stephens and Jiusto, 2010).[19] Evaluating the primary modes of knowledge-sharing in the CCS community – conferences, newsletters and journals – Stephens et al. found "an optimistic and non-critical perspective" about CCS to be dominant, which, in their view, "may detract from the community's collective capacity to critically evaluate the risks and potential negative implications" of CCS (2011: 385; see also de Coninck 2010; Malone, Dooley and Bradbury 2010).

The second consequence of the inherent partiality of epistemic communities is that, if policymakers rely too heavily on one epistemic community's knowledge, the (inherently) incomplete view of that community is likely to be translated into any policy vehicles into which it is adopted.[20] I will show this dynamic operating in key CCS policy planning documents in Chapter 6. This is amplified if there is a simplification in the process of translating the epistemic community's knowledge *into* the policy sphere. A consequence of the inevitable partiality of epistemic

[19] For example, Malone, Dooley and Bradbury (2010) showed that, since public knowledge of carbon capture is low, public surveys necessarily involve providing information as part of the survey. But their analysis of over a dozen such surveys found that the information "tends to produce pseudo opinions that reflect the pollster's or researcher's bias" (2010: 419). Stephens and Juisto (2010) found a large disjuncture between estimated spending levels and expected project numbers from industry, government, science, and environmental organizations (n= 10-30), and EIA estimates of plant numbers from estimated market demand (n = 2). This disjuncture is discussed in more detail in Chapter 6).

[20] As an example, if a national policy for substance abuse and addiction is based on the knowledge produced by epistemic community that does *not* consider family of origin, past trauma and low socio-economic status as important factors influencing addiction and recovery (for example a strictly biological model), then the policy itself will likely fail to account for these factors when policy interventions are fashioned.

community knowledge-production is that information and knowledge can be circulated and lent a legitimacy that exceeds the production of truth.

The third consequence cuts the other way: in agreement with Merton's work (above), there is a higher likelihood that a particular epistemic community's construction of policy problems and solutions will be adopted by decision-makers if the prescription accords with the pre-existing norms, beliefs, and policy enterprise of those decision-makers. After all, the success of an epistemic community "is not only dependent on claims of truth, but also on the existence of successful alliances with decision makers" (Stephens et al. 2011: 382). Stephens et al. call this an ''echo chamber'' effect, arguing that community knowledge claims tend to be in a format of "knowledge that can be accepted as the truth by policy makers" (*ibid.*). This contributes to 'channelized' knowledge-production, particularly in the context of state support for 'useful' science, or when expert knowledge from epistemic communities is actively solicited by the state.

How well does the epistemic community approach apply to the group of actors working to advance carbon capture and storage in Alberta? While the epistemic community approach highlights several problematic dimensions of the role of expertise in policymaking - how epistemological blinders might be amplified both within a community, and across into the policy contexts (the echo chamber effect) it suffers from a number of shortcomings. First and foremost, it assumes that there is a distinct separation between experts who try to influence policy (the epistemic community) and policymakers. Our exploration of how CCS has developed in Alberta over the course of this dissertation will reveal very porous boundaries between experts and policymakers. Secondly, as with most other analyses of CCS actors, epistemic community approaches fail to highlight the strong interconnections, and shared history, between the pool of experts on CCS, and experts in oil and gas topics. Lastly, while the epistemic community approach assumes actors within the community share standards of beliefs, norms, practices and validity, our

empirical case tends to support a more Latourian framing, to which I now turn, where these aspects need not be shared, and goals need only be temporarily reshuffled.

2.4 Actor-Network Theory: Translation and Composition

Many scholars working at the interface of policy and science stress that, "science is the core logic in modern systems of governance and power" (Greenhalgh 2011: 8, Rose and Miller 2008). As such, this dissertation takes the role of science and technology, and the technological character of CCS as a carbon control, as analytically important. I submit that, by applying insights from science and technology studies (STS), and in particular actor-network theory (ANT), one can gain a heretofore-unexamined perspective on the 'social life' of CCS. This helps me to properly historicize CCS technology, as well as to enable a view of how the scientific community, government and industry were able to work cooperatively to enable the possibility of carbon capture and storage to operate as a technological fix for Alberta's carbon control crisis. As Whatmore (2009) remarks, many environmental geographers are engaging with science and technology studies (STS) as a way to extend geographical knowledge about environmental controversies and the that role science and expertise play in environmental issues (for example, Braun 2006, Furlong 2011, Dempsey 2011).

Science and technology studies, broadly speaking, views science as a social practice, and includes work on the social construction of facts, the role of paradigms in producing scientific truth, and work that demonstrates scientific knowledge as a contingent, yet authoritative social practice. Another major finding of STS, expounded most systematically by Jasanoff, relates to the role of science in policy. Jasanoff contends that in their expanding role as advisors, scientists and technical experts have in many cases become no less than a "fifth branch" of government (2004: 1). Yet the result of such a position is that "science and the social order are *coproduced*" (Greenhalgh 2008: 17).

In this project, I borrow two concepts – translation and composition – from a subset of science and technology studies (STS) known as actor-network theory (ANT). ANT asks, "what work does 'science' do?" (Greenhalgh 2011: 339) by focusing on the total suite of entities involved in science and technological enterprise. Bruno Latour, a key ANT scholar, contends that scientific and technological pursuits produce effects in the world to the extent that a network of actors becomes enrolled in that pursuit. This involves the translation of diverse interests towards a contingently common goal.

The concept of translation is used in Chapter 4 to understand how Alberta's carbon capture and storage community was built out of the province's hydrocarbon networks. Translation is arguably the central concept in actor network theory, which is also known as "a sociology of translation" (Callon 1986). This concept is a useful way to trace *how* various actors and institutions came together in order to help construct carbon capture and storage as a (political) technology. It is a succinct way of understanding how networks of allies, facts and narratives, and calculative technologies are woven together over time to fashion a more or less coherent techno-political programme.[21] By highlighting how actors' goals and interests can become 'reshuffled,' it helps account for the transformation, over time, of carbon capture technology from antecedent technology (Chapter 4). The translation framework also allows one to account for some of the 'failures' of CCS, insofar as it regards technological and scientific failures and successes to be dependent on the continuous (re)enrollment of a network of actors.

Latour's most complete explication of translation is elaborated in his 1987 *Science in Action*. Starting from the premise that all scientific facts and all machines (physical technologies) are collectively composed by multiple actors, the work centres on the problem of the 'fact-builder,' usually a scientist or engineer, who wishes to advance an idea or technology (machine) by

[21] Although not pursued in this dissertation, the translation concept has many similarities to Laclau's concept of the political, contained in the notion of building chains of equivalence (see Laclau 2005).

spreading it in time and space (1987: 108). Latour identifies the quandary faced by all fact-builders: to spread a scientific idea or invention in space and time requires the actions of others (through financial support, paper citations, project collaborations, etc). Yet to involve others risks taking it out of one's own hands, opening the possibility that the fact/machine will change as a result of the involvement of others (1987: 108).[22]

As the solution to the quandary, scientists proceed through a process of translation, defined by Latour as "the interpretation given by the fact-builders of their interests and that of the people they enroll" (1987: 108). Translation is a two-part strategy: one devises strategies to *enroll* others in one's project, but one also devises strategies to *control* their behaviour or make their actions predictable (*ibid*.). The purpose of enrollment is, in short, to make others "believe it, buy it and disseminate it across time and space" (*ibid*.: 121), and the purpose of control is be the party credited with any success the fact or machine might bring.

The only way for scientists to succeed in their endeavours is, "to link their fate to that of other, much more powerful groups," ones with greater amounts of money, and who are also "on the lookout for new unexpected allies that can make a difference in their own struggle" (*ibid.*: 169). Governments and industry in particular, are the largest sectors enrolled in science, and as Latour contends, "[e]ssentially, R & D is an industrial affair financed out of tax money" (*ibid.:* 170). The necessity of translation produces Latour's first principle: that "the construction of facts and machines is a *collective* process" (*ibid*.: 29). As such, translation can be summarized by the dictum, "The machine will work when all the relevant people are convinced" (the conventional understanding of science and technology assumes, "Once the machine works people will be convinced") (1987: 10). It underscores that it is *the social relationships surrounding* an idea or

[22] For example, academics need to publish papers to do their work, but the process of peer-review publication means the paper and some of the ideas contained therein are inevitably changed from submission to publication, as a result of the peer-review process.

technology, as much as any intrinsic merits of the idea or technology itself, that tend to produce technological successes and failures.[23]

As the first of two moves in translation (enroll and control), Latour suggests several ways in which other actors can be 'enrolled' (*ibid*.: 108-121), two of which are discussed here. The first of the two relevant strategies is the "reshuffling" of other's interests and goals. This entails catering to people's explicit goals, yet doing so by "do[ing] away with explicit interests," as they understand them (*ibid.*: 114). This is done by convincing other actors that their explicit interests are not possible without considering one's new goals, new groups, etc. In other words, one offers people new interpretations of their interests (*ibid*.: 117), and posits that the fact-builder's fact/machine is a necessary tool to achieve these newly interpreted interests.[24]

The second of the two relevant enrollment strategies is "becoming indispensible," which is equivalent to Callon's notion of the "obligatory passage point" (1986: 203), whereby fact-builders are able to force other actors to converge on a certain purpose or question. When a fact-builder is able to construct such a strategy, "it means that whatever you do, and wherever you go, you *have* to pass through the [fact-builders'] position and to help them further their interests… it means that one version translates every other, acquiring a sort of hegemony" (Latour 1987: 120-1). Latour considers translation a "slow mobilization" that has the advantage "that particular issues …are now *solidly tied* to much larger ones (the survival of the country, the future of cars), so well tied indeed that threatening the former is tantamount to threatening the latter" (*ibid.*: 117).

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[23] Translation, furthermore, has both a linguistic (speaking to others interests) and a geometric (moving from one place to another) connotation, meaning it consists, at once, of "offering new interpretations of … interests" as well as physically channeling people and objects in space (*ibid*.: 117).

[24] Latour uses the example of Leo Szilard's efforts to convince the Pentagon to help him build a new atomic weapon. Generals were unconvinced that they should spend millions of dollars and countless years, on a new way of making weapons, when their goal was simply to win wars, which they believed could be done by improving existing conventional weapons. Szilard was able to enroll the support of the generals when he worked to re-interpret their goals thusly: "'What if the Germans got the atom bomb first? How will you manage to win the war – your explicit aim – with all your older and obsolete weapons?' The generals had to win a war… [yet] after Szilard's intervention they still had to win the war – meaning now a new atomic one" (*ibid.*: 114).

If the focus of translation is on the fact-builder, which typically refers to the scientist or engineer, is the concept useful for the case of CCS in Alberta, where it is difficult to tell whether it is scientists/engineers, or the state, or the fossil fuel industry leading the push? In Latour's words, "[t]here seems … to be a danger in extending the size of technoscience, so as to include in it supporters, allies, employers, helping hands, believers, patrons and consumers, because they in turn might be seen as leading the scientists" (*ibid.*: 175). This might lead one to conclude that science and technology are the result only of external demands or agendas, whereby science is wholly in service of political economy. But there is also a risk in thinking that it is only scientists undertaking all of the action, convincing resource-laden firms and governments to sign up for their visions, with few questions asked. The solution is to suspend the idea of the fact-builder as being strictly a scientist or engineer, and ANT scholars argue for agnosticism when it comes to the delineation of science as separate from any other domain. Such agnosticism can help during research, where actors wear "many confusing masks," making it difficult "to determine who are the scientists and engineers" (Latour 1987: 146).

In the end, argues Latour, "[a]ll the distinctions one could wish to make between domains (economics, politics, science, technology, law) are less important than the unique movement that makes all of these domains conspire towards the same goals" (*ibid.*: 222). With this view one can recognize that, "[r]ight from the start, technical, scientific, social, economic, or political considerations have been inextricably bound up into an organic whole" (*ibid.*: 84; see also Barry 2001), and that many things beyond laboratories and lab coats constitute science, "no matter how dirty, unexpected, or foreign they seem" (*ibid.*: 174).

The second concept I borrow from actor-network theory is composition. If translation helped to show that the carbon capture community is to a large extent built out of pre-existing oil and gas networks, composition will reveal how carbon capture is composed as a coherent, operationalizable, regulatable system in the present through the addition of new actors, new

institutional and regulatory supports and new rationales of legitimacy. Composition refers to the actions that actors undertake to bring heterogenous or even contradictory elements together in order to solidify an object (artefact) with the narratives and policy that bring it into being (fact) (Latour 2010). Latour uses the term to stress the labour that goes into the act of assembling the social realm, as well as to signal the contingency of composition ("de-composition"), since "[a]bove all, a composition can fail" (2010: 474). Using a composition framework is to look for both "[t]he social processes which multiply interests and experiences" (Chapter 5), as well as "those which unify and strengthen authoritative representations" (Mosse 2004: 665) (Chapter 6).

ANT-informed approaches reveal the irreducibly political character of science and technology because they reveal how the ends to which they can be applied are multivalent. Mitchell argues that disputes about technology "are disputes about the kind of technologies we want to live with, but also about the forms of social life, of socio-technical life, we would like to live" (Mitchell 2011: 239). But this relation is only ever understood by comprehending the social context within which the technology unfolds.

2.5 Research Methods

The objective of the dissertation is to understand why and how CCS is being developed in Alberta, and to what effect, with particular regard to how carbon capture operates as a political technology. The objective necessitates the development of an in-depth account of: a) a complex, multi-sited, multi-scalar social process – the trajectory of CCS technology and policy as a political technology, b) the historico-geographical specific context of the energy political economy of Alberta, and c) the mutually conditioning of the conjunction of process and context. To study CCS as a political technology is to be interested in how Alberta CCS projects are assembled within the context of multiple variously converging or countervailing processes.

In this section, I describe the research strategy and methods that I used to understand carbon capture and storage in Alberta in this way. Miller and Rose (2008: 6, see also Dean 2010: 39), argue that studies of regimes of government give priority to 'how' questions (see research questions Section 1.2), arguing that they direct the researcher to attend to the *practices* of government that form the basis of governing (as opposed to just discourses, or official rationales). Miller and Rose furthermore argue that 'how' questions involve a lightening of the weight of causality in favour of a multiplying of causalities. This is appropriate for the study of CCS, which faces numerous uncertainties, making establishing which processes and factors are determining its development trajectory a goal of empirical investigation, rather than a known starting point.

The case study methodology is the most appropriate for understanding a particular process in all its complexity. First, according to Yin, case studies are the preferred strategy when, as with this project, ""how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on "a contemporary phenomenon within some real-life context" (2003: 1). Second, a case study is especially valuable "when the boundaries between phenomenon and context are not clearly evident" (*ibid.*: 13) - when one would not be able to make an *a priori* distinction between the emergent phenomenon investigated and its context. This the case with carbon capture, where a myriad of social, political and economic contingencies constitute not only the context of its development, but will also heavily influence its trajectory and outcome. Third, case studies enable the production of "concrete, practical, and context-dependent knowledge" (Flyvbjerg 2001: 70), and therefore are an especially good method of developing an empirically thick account that specifically attends to the specificities of place.

The goal of this project is to "study through" (McCann and Ward 2012) the circulations, fixities and transformations of CCS technology and policy. Yet a project that seeks to understand how a political process works, with as rich a contextual understanding as possible, necessitates understanding it well in one case. The single case study is an ideal method to gain proximity to the

complexity of the "real-life situation" of how CCS operates in circulation and in place, permitting the high level of empirical detail and depth of understanding that can account for multiple causalities, complex networks of actors, institutions and regulatory complexity. Furthermore, far from providing simply a "provincial" understanding of CCS in Alberta, an up-close investigation of a process in one geographical locale and the 'travel' of political instruments and actors out of it may speak to other similar locales in the international CCS community, since many of the actors, institutions, knowledge sets, and processes contributing to the development of CCS in Alberta are the same or similar to those operating in other contexts.

I take general methodological guidance from the extended case method (ECM), as elaborated by Michael Burawoy (1998). According to Burawoy, ECM is a method that applies reflexive science (as distinguished from positive science) to social science research, "in order to extract the general from the unique, to move from the "micro" to the "macro," and to connect the present to the past in anticipation of the future," all by building on, refining and reconstructing existing theoretical arguments (1998: 5). ECM pays simultaneous attention to two relational processes. First, the researcher uncovers locally embedded understandings, institutions, and processes, or what Ward and McCann (2012: 47) refer to as the study of *situations*. And secondly, the local situation is studied for its connections to extra-local relations, connections, networks, and forces. This is analogous to the effort in critical policy studies to 'follow the policy' through globalizing networks and across jurisdictional spaces (Peck and Theodore 2012: 2). This dual focus on process-in-place and place-in-process makes ECM an appropriate methodological guide for my study, where the goal is to develop a contextually rich account of Alberta, but also to trace how and why Alberta has become an important site of the global push for CCS.

My analysis and conclusions will not constitute an attempt to extrapolate from one case to others. However, the Alberta case "is open for testing in relation to other interpretations and other research" (Flyvbjerg 2001: 76) for generalizability. As Kuus (2011: 278) argues, a single case

investigates the general discursive and social field that enables the dynamics studied, opening the possibility to generalize to *within* a suite of other cases with the same or similar dynamics (see also Sayer 2001: 100). As a "reflexive" single-case study, the validity of this research cannot be ascertained using criteria of replicability (Flyvbjerg 2001). However, it can be assessed using other measures, including data saturation from interviews and analysis of documents, and feedback from informants (Flyvbjerg 2001: 72).

2.5.1 Data Sources

My program of research relied upon a case study methodology, which consists of a number of data collection strategies and methods. Case studies allow the researcher to use multiple sources of evidence (Yin 2003: 14). I employed several data collection techniques that enabled me to uncover the rationalities, explanations, narratives, and the 'reasons for reasons' of actors involved in the development trajectory of CCS in Alberta. My data sources needed to yield data on what types of knowledge, expertise, rules and regulations are produced, altered or maintained through the development of CCS in Alberta, and how. A case study approach is well-suited for studying the emergence and circulation of ideas, policies and technologies. As Peck and Theodore suggest, researchers tracing ideas and policies should "embrace of a range of methodological strategies," (2012: 4) including discourse analyses, ethnographic observation and depth interviewing.

In a single-case study, the political and technical contexts, and historical processes are important aspects of the research. As such, one of my two central primary data sources was documentary evidence. Documentary evidence consists of publicly available reports, pieces of legislation, planning and policy documents, websites, etc. This evidence provided a good proportion of the background and contextual knowledge necessary to gain a nuanced picture of CCS in Alberta and beyond, and to identify possible causal explanations and develop working hypotheses.

Knowledge of documentary evidence was important in advance of interviews, in order to develop sufficient background knowledge to secure access to interviews with respondents. It was also necessary in order to ensure that my interview questions were well-informed, so that I had the best chance of seizing upon unexpected paths of discussion during the interview processes, and so that I was able to 'fact-check' explanations and hypotheses that I derived from documents with interview informants.

As such, the other main pillar of evidence was in-depth semi-structured interviews with both actors directly involved in the development and regulation of CCS in Alberta, and actors with expertise in Alberta's climate change and energy situations. The central purpose of the research - to investigate how CCS acts as a political technology - necessitates a research program that can follow and account for new types of knowledge, regulation, policy, actors, and discourses that produce or constitute these political technologies (Hajer 1995). Interviews are the best method to obtain an account of underlying processes, actions, rationalities and practices, since many of these cannot be ascertained through documentary evidence. Interviews are also necessary in order to better understand agency, uncertain processes, and to investigate the people practicing CCS. As such, they are the one of the best methods for getting at some of the 'reasons of reasons', early histories, and interpersonal relationships between subjects and institutions that are crucial components of apprehending how CCS operates as a political technology.

In order to gain as rich an understanding as possible, I developed an interview roster designed to garner the perspectives of a broad spectrum of the many individuals and organizations that represent a 'stake' in CCS in Alberta. I interviewed individuals and representatives of organizations involved in producing and circulating CCS policy and research, such as federal and provincial bureaucrats, but also consultants and representatives of industry, along with actors involved more directly in the development of the technology such as academics and engineers, and those who have declared opposition, circumspection or cautious support of the technology such as

environmental NGOs. I conducted 37 interviews over the entire course of fieldwork. The bulk of the interview program was carried out between September and December 2012 in Edmonton and Calgary, with a small number of interviews carried out in Ottawa in May 2013. The majority of interviews were 60-90 minutes, and all but two were recorded. All interviewees were interviewed under guarantees of confidentiality and anonymity.

Prior to commencing fieldwork, I anticipated a number of possible challenges, including access to informants and willingness to be interviewed (Kuus 2014). In order to address these challenges, I used snowball sampling, which consists of identifying potential interview informants through word of mouth by other informants, over time, as well as (with permission) using the names of interviewed subjects as a form of "social capital" to foster trust and interest with potential interviewees (e.g., "Mr. Lavellée has highly recommended that I interview you"). Snowball sampling is a strategy for access, but it also helps to ensure 'data saturation': having the 'whole story' about CCS, by having the perspective of as many people as possible.

In the course of fieldwork, both anticipated challenges - access to informants and willingness to be interviewed - arose to some degree but were mitigated, with two exceptions. The snowball sampling technique was generally very effective at alerting me to otherwise previously unknown actors in the CCS community, and most 'snowballed' potential interviewees were open to being interviewed. The two exceptions were access to industry and federal government representatives. I completed five interviews with industry representatives, but only one of these was with a representative of the four companies that were granted the 2010 subsidy funding.[25] As for the federal government, snowball sampling yielded the names of employees in the two most relevant federal ministries. Yet many of these persons were no longer actively working on CCS.

[25] I requested interviews with representatives of the other three companies: one company's chief ranking employee replied, declining an interview. The other two did not reply to multiple interview requests. In one interview with a non-industry representative, I mentioned my unsuccessful request to interview with Enhance Energy, who are undertaking the Alberta Carbon Trunk Line project. Their response was [I16] "Nope. They will not talk to you." This suggests that being shut out from interviews with three of the four original industry CCS project proponents was less a failure of tenacity on my part, and more a unwillingness to share on theirs.

Requests for interviews with one ministry were entirely ignored, while requests for interviews were granted with the other ministry, but required approval from somewhere higher in the ministry.

Snowball sampling is also used to achieve data saturation. I could have interviewed additional persons based on contacts I developed (I have at least 15 contacts that were not interviewed). These were all provincial and research/academic contacts. However, except for industry and federal government representatives, I found that I had a satisfactory number of respondents from various areas of the CCS community – engineers, bureaucrats, etc. While each individual interviewee near the end of the interview cycle was offering me a unique perspective, I was beginning to hear repeated information about the most relevant topics.

Beyond access, I entered the field aware that, when interviewing political and scientific 'elites,' the interview process holds the potential challenges and limitations associated with 'agent inflation' (Peck and Theodore 2012: 8), whereby informants may exaggerate the weight of their own agency or contribution to the process in question. I found that agent inflation was an interesting issue to work around. I also frequently encountered the opposite: the deflation of agency. A high proportion of interviewees made jokes or comments suggesting that they didn't have much they could tell me about the subject, when this was clearly not the case. It was interesting to note this "expertise deflation" as a specific technique used by interviewees. However, there were also cases of agent inflation, which are examined in detail in Chapter 5. It should be noted that this inflation was more structural – inflating the position of Alberta as a jurisdiction, and the accomplishments of the Government of Alberta as a whole, rather than an inflation of the individual I was interviewing.

A third challenge I was uncovering "'real' subject position[s]" (Peck and Theodore 2012: 8): many governments and bureaucracies, as well as many NGOs and think tanks, have become adept at contact with academics, and may deliver somewhat staged or scripted interviews that do not get

beyond the official 'party line' (Kuus 2014). I was frequently presented with what I perceived to be an 'official party line', a 'real' subject position, and a reflexively constrained middle position in the course of one interview. The presence of these subject positions is, of course, my interpretation, and is open to contestation. Frequently I would be offered the party line at the outset of the interview, and subjects would offer more candid perspectives once they felt more comfortable with the interview scenario or me.

I came to the field prepared with methods to address these challenges. The goal was to be able to capture the 'context of context,' and to get to the "hidden transcripts" of political rationalities (Scott 1990), social logics, and spatial assumptions of CCS actors. This was aided by triangulation with other interviews and data sources, striving for a plurality of informants (which was achieved through a pre-field mapping out of the social field, and by interviewing more than one informant per institution, which was done in many instances), and handing back informants circulating narratives for "verification, qualification, or rejection" (Peck and Theodore 2012: 8). I employed all of these strategies when possible.

In addition to interviews and documentary evidence, I was offered the opportunity to do a weeklong shadow position at the CCS Branch of Alberta Energy – the provincial government department with the most direct role in regulating carbon capture and storage in the province. I did not anticipate this opportunity, but took it, knowing that it would allow me to absorb the 'context of context' of this agency – to be able to map and observe how policy is made, to better understand the roles of the employees, and to observe the interactions between the Branch and the affiliated energy efficiency and renewables branches.

Not all aspects of policy change are legible to the researcher, and indeed in my case, my account is the result of those aspects of the development of carbon capture in Alberta that were legible to me. The *inevitably* partial nature of my research was due to restrictions to my access, as

well as time constraints, and the limitations of my own methodological and normative lenses. Therefore, any gaps in the analysis, and any failures of rigour, are my own.

2.5.2 A Note on Techno-Strategic Language

Before proceeding with the rest of the work, it is necessary to make a note on what Cohn calls "technostrategic language" (1987) and its use by researchers undertaking social studies of technical domains. In her work on defense professionals, she uses "technostrategic language" to refer to the specialized suite of language she needed to learn in order to carry out her research. To call the language and discourses used by her research subjects as techno*strategic* is used "to indicate the degree to which… strategic language and thinking are imbued with, indeed constructed out of, modes of thinking that are associated with technology" (1987: 690).[26]

Completion of this research project necessitated learning much specific technical knowledge, not only about carbon capture and storage technology, but also conventional and unconventional fossil fuel extraction, as well as in-depth knowledge of Alberta's regulatory system, including its technical regulations of oil and gas operations. I could not have completed this project without learning the details, acronyms, and specificities of the relevant technology, geology, regulation and history of the topic. As Kuus writes of work on the EU, the "sheer complexity of its institutions forces the researcher to spend vast amounts of energy putting together basic empirical data about them" (2014: 55).

Yet, for Cohn, the necessary work of learning these specialized terms, processes and epistemologies creates a bind for the researcher. In order to converse knowledgeably about the topic with respondents, one is required to learn, and to speak in their language. Kuus describes the language used by EU professionals as "the technical language of eurospeak," something

[26] Strategy refers not only to thinking about technology in terms of its strategic use; it is also "based on a … a way of looking at problems - formal, mathematical modeling, systems analysis, game theory, linear programming – that are part of technology itself" (Cohn 1987: 690).

respondents assume, "if they take the researcher seriously… that she speaks… too" (*ibid.* 56). Yet, the bind operates thusly: to learn and speak the technostrategic language of one's respondents creates the "risk of entrapment in the technocratic echo-chamber" (Kuus 2014: 55). The possible negative effects of this include both privileging respondents' own understandings of the content and context of the research (*ibid.*), as well as adopting subjects' frames of perceptions of the social world, "neglect[ing] to ask how these perceptions are produced in the first place" (*ibid.*).

In this research, this bind was overcome by developing literacy not only in the technical details of the topic, but also becoming well-versed in the literatures described above (political economy, science and technology studies, critical policy studies and governmentality studies), all of which provided critical lenses with which to see the ecological, economic, political and technological aspects of my topic.

Chapter 3: Carbon Captured – Hydrocarbon Economy and a Carbon Constrained Future in Alberta, Canada

"[E]nergy has become both Alberta's single greatest asset and one of its greatest liabilities…"

- Gordon Laird

"Alberta's tar sands embody a central contemporary tension between the need for oil, a fundamental global commodity, and the environment, which is put at risk along the entire oil production chain… Alberta's tar sands both encapsulate this fundamental conflict of our time while also foreshadowing the future of oil development."

- Angela Carter

3.1 Alberta's Fossil Fuel Political Economy

Alberta-based writer Gordon Laird summed up the province's spirit and substance when he remarked, "[i]n Alberta, energy is everything" (2005). This statement distills the context in which carbon capture and storage is being pursued in Alberta. This chapter develops the empirical context for the case study, showing that understanding Alberta as an "energy province" is key to understanding how and why carbon capture and storage is being pursued as a response to climate change. In Section 3.1, I introduce the broad contours of Alberta's fossil fuel-based economy, covering the oil sands boom, and its environmental and political effects. In Section 3.2, I further the discussions of the environmental dimensions of fossil fuel extraction, presenting theoretical lenses through which to understand the current conjuncture of Alberta's fossil fuel-based political economy. Section 3.3 details the regulation of climate change specifically, in Canada and Alberta. In the final section, I expand upon the picture sketched at the outset of the chapter, describing the current landscape of energy politics in Alberta and Canada, including current North American

energy infrastructure plans, mounting public opposition to such infrastructure, the pro-fossil fuel agenda of the governing federal party (2006-present), and notably, the public spotlight that has been turned to the Alberta oil sands/tar sands since the mid-2000s. Here, I advance the argument that the hydrocarbon agenda is under threat from climate change in the form of a carbon control crisis, in which negative publicity about carbon-intensity and other environmental impacts of oil development has produced threats to hydrocarbon industries and governments vis-à-vis their "social license to operate."

3.1.1 The Oil Sands Bonanza

Since the discovery of oil at Leduc on 13 February 1948, Alberta has been an energy province. Discoveries of vast deposits of coal, natural gas and other hydrocarbon products followed suit over the coming decades. Yet the energy province that Alberta is today is qualitatively different than it has been over the last half century. Since the mid 2000s, the province has become an epicenter of the world's more recent chapter in fossil fuel use – unconventional fossil fuels, specifically bituminous oil, called oil sands or tar sands.[27] Alberta's oil sands contain proven reserves of approximately 168 billion barrels, making them the third-largest proven crude oil reserves in the world, after Venezuela and Saudi Arabia (Alberta Energy 2014a, Pembina Institute 2014). The province is Canada's largest producer of conventional and synthetic crude, and natural gas, and has the second highest number of operational coal mines after British Columbia.

Oil sands became of interest for their economic potential as far back as the 1700s, but concerted research into extraction technologies began in the 1920s, and small-scale production commenced in the late 1960s (Chastko 2004, Nikiforuk 2008). For most of their history, oil sands were too expensive to mine. Even after the first oil sands mine, operated by the Great Canadian

[27] Unconventional oil is that oil obtained from methods other than conventional terrestrial well drilling, such as shale oil, oil sands, deep sea drilling or arctic drilling. It is also refered to as "extreme energy" by opponents.

Oilsands Company (now called Suncor Energy) opened in 1967, oil sands operations were generally considered uneconomic. Years of government-subsidized research into mining and extraction technology, such as that conducted by the Alberta crown corporation Alberta Oil Sands Technology and Research Authority (AOSTRA) during the 1960s to 1980s (see in Chapter 3), went into driving operating costs down. As such, by the time of high oil prices in the early 2000s (Bridge and Le Billon 2012: 88), the scales of viability for the oil sands were tipped. The combination of mature technology and high prices provided the requisite amount of confidence on the part of investors, resulting in an historically unprecedented oil sands boom (Chastko 2004).

Within a matter of years, Alberta saw dramatic increases in unconventional production, through both open-pit mining or steam extraction.[28] Oil sands production more than doubled between 2000 and 2009 - from 0.6 million barrels to 1.35 million barrels per day (Carter 2010: 2). The upsurge in oil sands production "filled the gap" left by conventional oil production (*ibid.*), the growth rates of which had begun to flatline in the late 1990s. By 2002, tar sands production exceeded conventional oil production (Mansell and Schlenker 2006: 14), and by 2012, the oil sands accounted for 56% of Canada's national oil production, with the proportion growing yearly since then (Pembina Institute 2014, National Energy Board 2013).

For Gordon Laird, "[t]he oil sands are a perfect example of how much energy markets have changed" (2005: 160) – referring to the new normal of high cost, higher risk unconventional oils (see also Bridge and Le Billon 2012). And as the oil sands industry solidifies as the new normal of Canadian oil production, forecasts by industry and governments for much of the last ten years have suggested the possibility of large increases in production to 2020 and beyond. A prominent forecast

[28] Steam extraction is accomplished with a suite of techniques called Steam Assisted Gravity Drainage (SAGD). This involves injecting a subsurface bitumen deposit with steam to 'loosen' oil deposits from sand, and bring them to the surface. While open pit mining appears more ecologically destructive, entailing the wholesale removal of 'overburden' (i.e., the boreal forest), SAGD may be just as, if not more, destructive. The network of wellpads, and road and pipeline access routes creates landscape fragmentation, and the steam generation necessary for SAGD requires massive inputs of natural gas and water.

by the Canadian Energy Research Institute (CERI), for example, shows a "realistic scenario" with continuous oil sands production increases until 2035 (Honarvar et al. 2011; see also Bramley et al 2011: 25), resulting in a 150 percent production increase between 2010 and 2035.

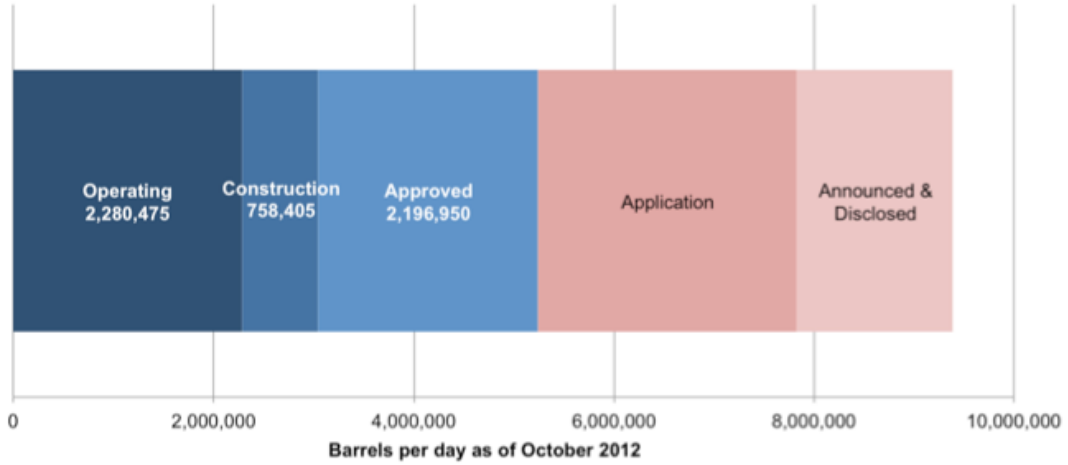

Figure 3.1 Oil sands operations and forecast expansion, as of October 2012.[29]

Given the rapid drop in oil prices in 2014, with little certainty of near- to medium-term prices, it remains to be seen whether such forecasts are "realistic," and will translate into future increases in production, and concomitant emissions. Worldwide, over US $33 billion in capital expenditures (capex) for oil production have been clawed back for 2015 due to the slide in oil prices (Carbon Tracker Initiative 2015), and Alberta oil sands supply is the pre-dominant geographical location of price sensitive capex (Carbon Tracker Initiative 2014a). As of August 2015, 1.2 million barrels per day of approved oil sands production is on hold, cancelled or suspended (Oilsands Review 2015).

[29] From Grant et al. 2013: 2. While this figure presents figures from 2012, the current operating (production) totals are not significantly higher as of late 2015. The most recently available Government of Alberta figures for total oil sands production (mined and in situ) are about 2.3 million barrels per day (bbl/d) in 2014. While earlier in 2015, the Canadian Association of Petroleum Producers predicted Alberta production (oil sands plus conventional) of about 3.8 million barrels per day (bbl/d) for 2015, the year-end result is likely to fall closer to 2.9 million barrels per day (bbl/d) (non-attributable reference source).

Nonetheless, projects representing over 4 million barrels per day in capacity have already been approved by federal and provincial regulators, and plans for an additional 4 million barrels per day have been announced (Bramley et al., 2011: 25, Pembina Institute 2014) (Figure 3.1). These estimates translate into an even sharper rise in greenhouse gas emissions from the sector. Grant et al. remark that "industry's own forecasts" indicate "'critical' ecosystem and air quality limits," will be surpassed by such production increases (2013: 1-2). Because of the number of tar sands projects already operating, under construction, or approved, Grant et al. argue that, "the majority of the [environmental] impacts may already be ""locked in" and isn't likely to be meaningfully reduced without serious efforts by all parties" (2013: 1). Such a statement speaks to the challenges faced when trying to reduce greenhouse gas emissions in the face of a well-established economic pathway. It also begs the question of how so many tar sands projects were approved in such a short amount of time. The rate at which oil sands lands were leased to producers at the onset of the boom in the early 2000s entailed the development of a new industry so swift that even industry executives were surprised and concerned about impacts (Nikiforuk 2008: 27).[30]

If the pace of the boom took even insiders by surprise, then it is not surprising that many Albertans, Canadians and global citizens were unaware of the oil sands projects that had recently begun operations, were under construction or were 'locked-in' with regulatory approval. The speed of oil sands take off led Alberta political scientist Ian Urquhart to claim, "we are living during one of the greatest land rushes in Alberta's history, one where virtually all of northern Alberta's public lands have been allocated to the forest products and oil sands industries and where petroleum and natural gas rights have been sold for tens of millions of hectares" (2005: 140).[31]

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[30] The CEO of one of the two biggest oil sands operations, Syncrude's Jim Carter, said "We just hope the coming development is logical and managed" (in Nikiforuk 2008: 27).

[31] Indeed, according to Dr. Richard Thomas, in the late 1990s, the combination of forestry and oil and gas activities meant that the relative deforestation in Alberta's southern boreal was higher than that in the Amazon rainforest (in Urquhart 2005: 140). A 2014 report from the World Resources Institute confirms that the trend holds, with Canada being the leading country of degradation of pristine forests in the world (World Resources Institute 2014, Chung 2014a).

3.2 Environmental Effects of Oil Sands: SNAFU?

By January 2013, the Pembina Institute had reported that over two-thirds of the total oil sands land area equivalent to 93,000 square kilometres had been leased to companies (Pembina 2014)[32] (the land area of Ireland is 84,000 km^2). The government grants these leases without an environmental assessment (assessments for some, but not all, projects are completed once approval has already been granted). Yet the effects of the oil sands production rush has had a number of significant environmental effects (see Mech 2011 for a comprehensive overview). Both surface mining techniques and underground steam extraction techniques cause high land disturbance of the surrounding boreal forest. Production also results in land, water and air pollution (particulate matter deposition), and requires high volumes of water withdrawals. Extraction operations produce "tailings ponds," large waste reservoirs for which no adequate processing solution yet exists. These impacts can be considered localized/regional impacts,[33] which also produce adverse social impacts on nearby communities, such as health impacts, and disruptions to local and/or indigenous traditional food and medicine systems (through reductions in game, fish, and plants). The loss and/or threat to indigenous land claims and resource use translates into infringements to noth traditional land use, and to formalized treaty arrangements and other politico-judicial commitments (such as the obligation to free, prior and informed consent of indigenous communities in impactful resource developments) (Mech 2011).

It is the localized impacts, in particular land disturbance, that first helped spawn an extra-local opposition to Alberta's rapid oil sands development, through imagery of large-scale

[32] Similar to the caution in using figures from energy forecasts that often end up as triumphalist narratives, it is important to recognize that projects with regulatory approval are not yet "done deals," thus neither are their projected production rates and emissions rates. For instance, producers still face many challenges in exploiting the oil sands, not the least of which is controlling costs within a very expensive mining and refining process, especially given the decline in oil prices from autumn 2014 until the present. Pipeline capacity is another issue confronting the oil sands industry's ability to expand, and one that has now articulated into social protest against the projects.

[33] For more on the impacts of the oil sands, see Grant et al.'s 2013 *Beneath the Surface: a review of key facts in the oil sands debate.*

deforestation and landscape industrialization (Remillard 2011). Yet while the aesthetic politics of the oil sands have focused on local landscape industrialization, arguably the core of opposition to oil sands on environmental grounds is about its global climate change impacts. Alberta's oil and gas industry emissions have soared due the rapid expansion of the oil sands industry over the past two decades (Bramley et al. 2011: 24); Grant et al. (2013: 7) report that, as production from Alberta's oil sands increased by 260 per cent between 1990 and 2010, corresponding greenhouse gas emissions almost tripled.[34]

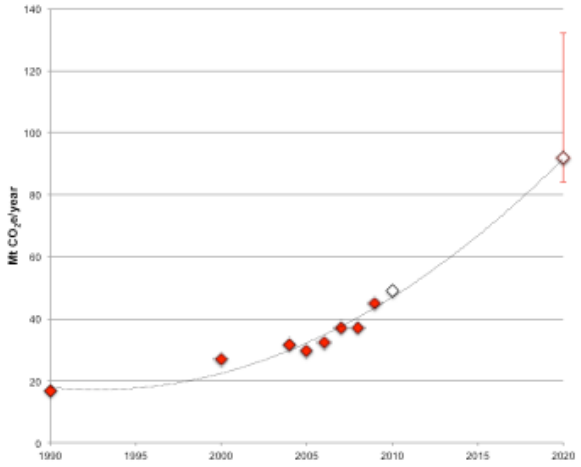

Figure 3.2 Actual and projected greenhouse gas emissions from oil sands extraction and upgrading.[35]

This increase in emissions means that oil sands extraction constitutes a major share of provincial greenhouse gas (GHG) emissions. By 2009, oil sands extraction and upgrading accounted for almost one-fifth of Alberta's total GHG emissions, representing almost half the growth in Alberta's emissions since 1990 (Bramley et al. 2011: 24). By 2010, fully 7 percent of Canada's total GHG emissions came from oil sands plants and upgraders (Pembina 2014, Environment Canada

[34] Greenhouse gas emissions from the Alberta oil sands increased from 17 megatonnes (Mt) in 1990 to 48 Mt in 2010 (a 180 percent increase in emissions) (Grant et al. 2013:7).
[35] Reproduced from Bramley 2011: 25.

2012). At least until the crash in oil prices that occurred in the fall of 2014, the oil and gas industry and governments were operating with an expectation of expanded production of the oil sands. Emissions would concomitantly rise as a result (Figure 3.2).[36]

The increase in greenhouse gas emissions from the oil sands can be attributed not only to the absolute increase in the rates of extraction and upgrading of oil sands, but also to the relative carbon intensity of oil sands production. Oil sands are "significantly more greenhouse gas-intensive than conventional oil production" (Grant 2013: 4),[37] because of the high energy demands of its production. It requires a significant amount of energy to surface mine bitumen from shallow deposits, to extract deeper deposits with steam, and to mechanically separate usable oil from the naturally occurring sand/water/oil mixture during the upgrading process. For example, oil sands operations consume about 20 percent of annual Canadian natural gas demand[38] (the equivalent of heating 3.5 million Canadian homes) (Mech 2011).

As a result of the production boom, oil sands emissions are growing faster than any other source in Canada (Environment Canada 2014). This increase in emissions has consequences for both Alberta and Canada as a whole: Alberta is home to 10.9 percent of Canada's population (Statistics Canada 2014), yet it contributes a full third of Canada's greenhouse gas emissions (Bramley et al. 2011: 1). While the oil sands contribute a small amount to greenhouse gas emissions

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[36] According to the most recent projection from Environment Canada, in step with the large projected increases in production, emissions are expected to double, from 48 mt in 2010 to 104 mt of greenhouse gases in 2020, under existing federal and provincial climate policies (Bramley et al., 2011: 24, see also Grant et al. 2013: 7, Environment Canada 2012).
[37] The oil sands extraction process has a low EROI ("energy returned on energy invested") ratio, meaning that the ratio of usable energy acquired from oil sands oil is low compared to the amount of energy expended to obtain it. Petroleum Technology Alliance Canada (PTAC) estimates that the oil sands has an EROI of 4:1 (it takes one barrel of oil equivalent energy to produce four barrels of oil sands oil), while typical Middle Eastern conventional oil has an EROI of 20:1, and early crude production from Alberta in the 1940s had an EROI ratio of over 30:1. The degree to which oil sands are more emissions intense has been a topic of controversy. Estimates of relative carbon intensity vary depending on whether averages or best practices are used, and whether emissions intensity is calculated based on the entire life cycle (extraction, upgrading, transport, refining, and end use) or production alone (extraction plus upgrading), the stage where conventional and oil sands oil vary most. A Natural Resources Defense Council study compared production emissions (not life-cycle emissions), indicating that per-barrel GHGs associated with oil sands production were an estimated three to four-and-a-half times higher than average for North American conventional crude oil (Grant et al. 2013: 5).
[38] Each barrel of SAGD oil uses 1600 cubic feet of natural gas, and each barrel of mined crude oil requires about 700 cubic feet of natural gas.

in absolute terms, contributing 0.15 percent of global GHG emissions (McCarthy 2013), critics respond that any single source of emissions will appear relatively small in a global total, and that oil sands emissions *are* globally significant, "because they represent the main barrier to meeting Canada's national and international climate commitments" (Grant et al. 2013: 12; see also May 2011). Indeed, by December 2011, when Canada legally withdrew from the Kyoto Protocol (May 2011), Canada's greenhouse gas emissions were a full third above Kyoto Protocol targets.[39]

Canada is considered an environmental and climate laggard (see below), ranking near last or last in rankings of the Organization for Economic Co-operation and Development (OECD) for country environmental performance measures (Waldie 2013, Nikiforuk 2008[40]). Several scholars argue that, despite high levels of public concern, Canada's record on environmental protection is poor (Weibust 2009, Harrison 1996, Soron 2004, Urquhart 2005). In Alberta, natural resource and environmental regulations and policies are consistently far less stringent than most Albertans, Canadians and concerned commentators would prefer (Soron 2005, Urquhart 2005). Furthermore, an 'omnibus' 2012 Federal budget bill (Bill C-38) made sweeping changes to Canada's most important environmental laws, thereby weakening already feeble federal oversight over oil sands development by making environmental impact assessments (EIAs) more discretionary, and also weakening protection for species at risk and fish, which had previously triggered federal EIAs (Pembina Institute 2014).

In a 2010 analysis of the environmental impacts of oil sands development, Carter identifies three central problems with Alberta's provincial regulatory system: ineffective and delayed consideration of environmental impacts, important regulatory gaps, and insufficient management of cumulative impacts. The first issue, ineffective and delayed consideration of environmental

[39] Upon Canada's withdrawal, it was criticized by other nations for "demoralizing" international climate change efforts. Estimating 74 Mt in projected increases from the oil sands, and decreases of about 54 Mt in the emissions of other sectors, the entire 20 Mt projected increase in Canada's emissions between 2005 and 2020 will come from the oil sands (Pembina Institute 2014; see also Environment Canada 2012).

[40] Nikiforuk cites a 2005 study that places Canada 28th out of 29 in Organization for Economic Co-operation and Development (OECD) nations (2008: 135).

impacts, relates to the relative power of Alberta Environment and to the lack of bearing that environmental impact assessments (EIAs) have on the leasing and permitting process for energy projects. Carter argues that Alberta Environment, the ministry responsible for regulating environmental impacts of hydrocarbon projects, "is in a structurally weak position in the decision making and regulatory process" (2010: 7; see also Timoney and Lee 2009: 65), in comparison with other departments also responsible for regulating oil and gas resource extraction, such as Alberta Energy and the provincial energy regulators.[41] She argues that Alberta Environment input occurs too late in the regulatory permitting process, after land leases have already been issued and property rights assigned (see also Urquhart 2005).[42]

No environmental assessment is required in advance of the issuance of oil sands leases, which are overseen by the Crown Mineral Disposition Review Committee (CMDRC). At the CMDRC, air, land and water impacts are considered during the initial review of a company's request for land, before the lease is granted. Holroyd, Dyer and Woynillowicz note that this is "the one and only opportunity during the tenure process to consider the environmental and social impacts of granting oil sands rights" (2007: 21-22), but it is not a formalized environmental assessment process, nor are cumulative impacts considered. Furthermore, the role of the CMDRC is advisory only – Alberta Energy holds final authority on posting land for auction (Carter 2010: 8).

While environmental effects are considered more thoroughly through environmental impact assessments (EIA) conducted by Alberta Environment (Carter 2010: 8), after the land lease is granted, these EIAs are transferred to the Alberta Energy Regulator (formerly the Energy Resources Conservation Board (ERCB), and earlier, the Energy and Utilities Regulator (EUB)), who

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[41] There have been several changes to the organizational structure of Alberta's energy regulators over the past decade. Prior to 2008, the energy regulator was the Energy and Utilities Board (EUB). From 2008-2013 (which included the period of fieldwork for this project), regulatory authority was split between the Energy Resources Conservation Board (ERCB) and the Alberta Utilities Commission. As of June 2013, a "single regulator," known as the Alberta Energy Regulator, came into effect – encompassing the ERCB, the Department of Energy, and taking over certain environmental regulation responsibilities from Alberta Environment & Sustainable Resource Development.

[42] For a description of the oil sands tenure allocation process, see Holroyd, Dyer and Woynillowicz (2007).

has final say in whether or not a project is in the public interest, environmental impacts being only one consideration (Vlavianos 2006: 46). Carter reports that persons "familiar with the workings of the former EUB noted that the board was under continual political pressure to approve the projects for which Energy had already sold access rights" (2010: 8). Thus she concludes that, "[o]verall, the ERCB's and Alberta Energy's interests have consistently overridden any concerns raised by Alberta Environment in decisions on the tar sands," something that is "common knowledge both inside and outside the public service" (2010: 8).

Second, the ineffective consideration of environmental matters in the oil and gas regulatory regime points to the larger problem of key regulatory gaps that exist with respect to land, wildlife, air and water protection in the oil sands (Holroyd, Dyer and Woynillowicz 2007; Carter 2010: 9).[43] For instance, with respect to land and water protection, for the first forty years of oil sands operations, tailings treatment and management was conducted on a largely voluntary basis. This resulted in "vast lakes of polluted wastewater accumulated on the landscape" (Pembina Institute 2013: 3). Then, in 2009 the provincial regulator introduced Directive 074 to establish a consistent approach to tailings waste, with the goal of eventually reducing tailings volume. However, the Pembina Institute reports that the directive "has not been enforced….because its design was limited to only require operators to reduce a portion of the volume of future tailings waste, tailings volumes continue to grow," from 50 km^2 in 2005, to 130 km^2 in 2009, and 176 km^2 in 2010 (*ibid.*). With respect to air protection, there are no regulated limits to greenhouse gas emissions from oil sands at the federal level, and modest limits to the intensity (not absolute amount) of emissions at the provincial level (see Sections 3.3.2, and 6.3.3).

[43] Carter also points to the problem of "ineffectual public consultation," an issue recognized by several scholars with regard to Alberta's natural resources governance processes (Hoberg and Philips 2010, Acuña 2007, Fluet and Krogman 2006, Urquhart 2005). Similarly, Vlavianos (2007a) has noted the "complete lack of public participation" at key points in energy development decision making processes.

Third, Carter identifies the "analytical gap" in considering the cumulative impacts of projects. There is no law or formal regulatory framework for managing cumulative environmental impacts associated with oil sands development in Alberta, nor is there any monitoring or enforcement system in place to measure ecosystem capacity limits (Royal Society of Canada 2010). Rather, every oil sands project is treated as an isolated industrial operation, and evaluated only for its local environmental impact. The cumulative impacts of adjacent, preceding or anticipated projects do not form a part of the calculus of environmental impacts, nor do long-term, long-range effects environmental effects.[44] The Royal Society of Canada (2010) submitted that a lack of both provincial and federal regulatory oversight has resulted in a failure to effectively assess the cumulative impacts of oil sands development.

3.2.1 Alberta: Petro-state ...Or Carbon Captured?

Together, regulatory gaps, delayed environmental consideration and the lack of consideration of cumulative impacts constitute a weak environmental regulatory system, which then begs the question, "what accounts for these regulatory patterns?" (Carter 2010: 13). A supply-side analysis asks how oil sands production - given its high cost, technological barriers, and environmental burdens – was constructed in the first place, through both decades of concerted effort and historical fortune. The next two sections present three institutional and regulatory explanations for Alberta's inadequate environmental regulatory patterns. I argue that the particular trajectory that Alberta's oil sands development has taken is explained less by oil demand than by interconnected political economic factors: a) a longstanding petro-developmental state apparatus (Section 3.2.1), b) an environment in which regulators are 'captured' by the industry interests of oil

[44] While there have been multiple attempts at "institutional integration" in order to reduce fragmented decision making in the oil sands (such as the Cumulative Effects Management Association (CEMA) and the Regional Sustainable Development Strategy (RSDS)), these processes have been plagued by "continual delays" and unproductive conflict (Carter 2010, Hoberg and Philips 2010).

(Section 3.2.1), and c) the product of the particulars of Canada's constitutional division of powers, which leaves large governance gaps in environmental regulation (Section 3.2.2).

In her attempt to analyze the reasons for high environmental impacts from the Alberta oil sands, Carter contends that,

> "the Albertan petro-state has developed environmental regulation processes and institutions that forward rapid, extensive oil development and do not meaningfully restrain the resulting environmental impacts. The shared interests by government and industry … amounts to strong consent for tar sands developments and… an environmental policy regime that is biased toward tar sands development" (2010: 4).

Others have argued that Alberta can be understood as a "petro-state"[45] (Nikiforuk 2008, Adkin forthcoming) or a "petro-province" (Zalik 2012). But what is a petro-state, and how does status as a petro-state lead to unrestrained environmental impacts? In this section, I briefly outline the petro-state thesis, and review the ways in which the concept can apply to Alberta and/or Canada.

At a general level, 'petro-states' are those states characterized by high dependence on oil export revenues, and a particular suite of political and economic challenges (Carter 2010) associated with such dependence. These challenges include poor long-term economic growth, non-diversification of the economy, vulnerability to price shocks, poverty, high inequality, wasting of resource rents, and problems such corruption, authoritarianism and poor governance (Ross 1999).[46]

The petro-state thesis focuses on the political consequences of the oil resource curse. The thesis was elaborated by Terry Lynn Karl (1997), who sought to answer why capital-deficient oil-exporting states seemed to be unable to translate their oil boom windfalls into stable and self-

[45] For example, in mid-2013 *The Guardian*'s George Monbiot argued that Canada was evolving into a "thuggish petro-state, …where you basically have a group of oligarchs who control the fossil fuel revenues and end up controlling the political system" (Cameron 2013).

[46] The resource curse is also associated with minerals like diamonds and copper, and timber (although Karl argues that oil produces the most extreme versions of the resource curse).

sustaining development paths, regardless of regime (democratic, authoritarian), geographical location, and history.[47] Key to understanding Karl's formulation is that high-dependence on primary resources is most often coupled with state resource sovereignty (state ownership of oil resources); in most jurisdictions, it is the state that legally holds title to oil resources (Emel, Huber and Makene 2011, Bridge and Le Billon 2012). Such an arrangement makes the state the landlord of the resource (Mommer 2002), who collects rents through royalties or taxes from private producers, or through nationalized oil companies (NOCs) or para-statal corporations. As such, it is the state that determines how much resource rent enters the economy and where benefits from windfall revenues are distributed.

This state resource sovereignty produces a tendency towards rentier-state effects, whereby state actors begin to consider resource rents as an important state fiscal goal (Humphreys, Sachs and Stiglitz 2007, Zalik 2012). The result is that state institutions begin to orient their goals around the expansion or maintenance of oil revenues. This creates "a distinctive type of institutional setting, … the petro-state," where political rationality becomes blurred with economic rationality, encouraging political rent distribution (Karl 1997: 16). Fiscal reliance on oil money produces a positive feedback cycle: "when faced with competing pressures, state officials become habituated to relying on the progressive substitution of public spending for statecraft, thereby further weakening state capacity" (*ibid.*). Large revenues from rents create powerful incentives to orient institutions, decision-making frameworks, property regimes, and the loci of authority towards further entrenchment of dependency on oil revenues. That is, oil resource rents produce the onset of "long-term institutional inertia," or a path dependency, in which state institutions become

[47] While the petro-state concept was first developed in reference to "low-absorbing" (qua developing) economies, such as Nigeria, Venezuela and Mexico, the oil resource curse has a valid applicability to Alberta. In 2001, Timoney and Lee suggested Alberta that was a "third world analogue" in terms of the negative environmental consequences of its timber and oil and gas management regimes. Indeed, Carter submits that Alberta is one of several sub-national ""first-world" petro-polities, such as Saskatchewan, Newfoundland and Labrador, Alaska and Wyoming, exhibiting parallel "crippled" environmental policy trends (Carter 2010: 19).

focused on the further development of the rent-producing resource, rather than towards diversified economic development (Carter 2010). For Carter, this institutional molding "result[s] in a weakened environmental policy system that cannot mitigate against even the worst ecological impacts of the tar sands" (2010: 3).

So is it accurate or analytically valuable to consider Alberta a petro-state, as Carter and other critical scholars do? First, the Alberta Crown owns 81 percent of Alberta's oil sands mineral rights (Alberta Energy 2015), making the Alberta provincial government the landlord of oil resources.[48] Second, 'high dependence' on oil revenue is generally considered to be when it comprises one third or more of exports, GDP or government revenues (Carter 2010: 2 (fn. 4); Ross 2001; Sachs and Warner 2001). According to Alberta Energy (2014a), the energy sector accounts for 27.6 percent of Alberta's GDP. However, backward and forward linkages to and from the energy sector to other sectors like construction, manufacturing, transportation and utilities, finance, and business and commercial, in all likelihood entail a much higher energy-dependent GDP overall. Third, the Alberta government collects large rents (direct revenues, royalties and taxes) from oil and gas. In the period from 2003-04 to 2006-07 the provincial government collected $4.3 billion in revenues, accounting for over half of total provincial revenue (Carter 2010: 13). These are truly significant revenue shares.[49]

Fourth, in line with Karl's contention that petro-states are characterized by the conflation of oil-centred economic rationalities and political rationalities, Carter argues that the "single-minded prioritization of hydrocarbon extraction" is the sole economic "strategy" of Alberta's elected and bureaucratic bodies (2010: 4). This is reflected, for instance, in ERCB decisions on whether or not to

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[48] Although, Carter notes that the federal government could claim jurisdiction in areas related to mineral rights, "however, the extent of these powers is unclear, contested and undertested" (2010: 7, see also Vlavianos 2007c: 67-68, 72).

[49] However, it should be noted that Alberta under-collects on royalties compared to similar jurisdictions: Alberta collected only 69 percent of available revenues between 1995-2002, compared to Norway and Alaska, which collected 88 percent and 99 percent, respectively (Taylor 2006, see also Shnurr and Swatak 2010). This seems to contradict an assumption of the petro-state thesis - that oil-dependent states seek to maximize oil revenue.

grant permission for energy projects: projects must be shown to be "in the public interest," but public interest is made equivalent to (and limited to) the collection of rents (interviewee #I12, Kwasniak 2002: 27). It is also reflected in the "extensive financial subsidies" to the provincial government grants to fossil fuel industries, in the form of research and development funding, subsidies, and tax incentives like the Accelerated Capital Cost Allowance (2010: 172; see also Plourde 2009).

Alberta also features a fifth characteristic of petro-states: the "conservative effect" of natural resource wealth on state power (Goldberg, Wibbels, and Mvukiyche 2008), and the tendency of governments in oil-wealthy jurisdictions to retain power for long periods of time (Karl 1997, Ross 2001). The Alberta government was led the Progressive Conservative Party in an uninterrupted series of terms between 1971 and 2015, meaning that the distinction between 'state' and 'government' for over 40 years was particularly thin. The province has had only three change of government in its 109-year history, and right-wing parties have formed the government without interruption for almost 80 years, beginning in 1935 with the Social Credit Party and ending with the election of the centre-left New Democratic Party in May 2015. The political-economic dynamics in Alberta correspond to a number of other features that scholars have associated with petro-states and resource-dependent jurisdictions. Ross (2001) and Karl (1997) have linked oil resource development to the "taxation effect" and an associated dampening of citizen engagement, arguing that oil revenues enable states to reduce domestic taxation, which may enable decision-makers to craft policies without consideration of the scrutiny of citizens, producing a lack of accountability and voter engagement.[50] The lack of accountability produces voter cynicism and other "electile dysfunctions," such a gerrymandering and disparities in the relative power of the rural electorate (which tends to vote conservatively) (Soron 2005). Alberta typically has the lowest voter turnout in the country (Nikiforuk 2008), which has tended to further entrench the rule of the Progressive

[50] Alberta is the only province without a sales tax, and until 2015, employed a regressive 10 percent flat rate income tax.

Conservative Party. The largest voting block in Alberta by far is the non-voting public.[51] As a result, Soron contests the "tenacious myth that the Alberta electorate is an undifferentiated mass of riled-up neo-conservative "true believers,"" arguing instead that "Alberta's political culture is defined [instead] … by an overall process of de-politicization" (2005: 66, 67).

In this research, the petro-state concept provides a general heuristic for understanding the major political economic framework that surrounds the pursuit of carbon capture and storage in Alberta.[52] The key contribution of this concept is that it demonstrates why the Alberta economy continues a path dependency of non-renewable resource development, despite rising capital costs, declining profit margins, and in the face of dangerous climate change, an inevitable 'carbon bubble.'

However, the petro-state thesis is not a complete picture of the political geographies of the climate-fossil fuel nexus. The petro-state thesis does not offer a finer-level resolution to examine the *mechanisms* through which, for example, economic rationalities of oil production become incorporated and institutionalized in state agencies and institutions. As such, it does not provide sufficient resolution to explain the three central problems with Alberta's provincial regulatory system articulated by Carter (ineffective consideration of environmental impacts, insufficient management of cumulative impacts, and regulatory gaps).

The notion of regulatory capture provides another frame of analysis for why many of the adverse effects of oil and gas development in Alberta have been insufficiently regulated. The concept refers to the general problem of political influence, whereby special interests affect state

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[51] Soron describes how in the 2001 "cake walk" election, where the Progressive Conservatives won 90 percent of the seats, "the number of people that voted for the Tories was about 270,00 less that the number that didn't vote at all" (2005: 74) - of a total population of 2,941,150 at the time.

[52] Not all scholars agree that the petro-state is an appropriate analytical category to explain the oil and gas political economy of Alberta. For instance, the University of Alberta's Dr. Andrew Leach. In a 2013 piece, he provides economic evidence of the relatively small share of oil and gas in the Canadian economy. However, as the title of the article suggests, Leach's contestation of the application of petro-state label is to the *federal* level. While Leach's data shows that the case for calling Canada a petro-state is weak, it does not refute the validity of applying the petro-state label to the province of Alberta (which I contend is appropriate, given that provinces hold exclusive rights over natural resource development.

regulatory and political processes, "bias[ing] the incentives of regulators and governments to act in their interests rather than in the broader public interest" (Helm 2006: 174; Amann 2006). Dal Bó defines the concept more narrowly as "the process through which regulated monopolies end up manipulating the state agencies that are supposed to control them" (2006: 203). Regulatory capture is most associated with industries that have a few large players, such as utilities, banking, and telecommunications. According to Wilson, regulatory capture "occurs when most or all of the benefits of a program go to some single, reasonably small interest (an industry, profession, or locality) but most or all of the costs will be borne by a large number of people (for example, all taxpayers)" (1989: 76).

The structure and history of the advancement of CCS in Alberta is not intelligible without an understanding of the particular nature of the relationships between the provincial government, the hydrocarbon industry, academia and other groups. Some of these relationships are necessary and complementary to the advancement of public interest goals. However, there are some problematically close relationships between industry and the provincial government, something that is general knowledge amongst the Albertan and Canadian public (explored in Chapter 6).

The April 2011 Rainbow pipeline spill provides an example of the regulatory capture of oil industry interests. The spill was the worst in Alberta in thirty-five years, caused by a leak in a Plains Midstream pipeline. In a report on the spill, Greenpeace attributed regulatory capture as the central cause of both the pipeline break and the subsequent handling of effects (Greenpeace Canada 2013), and used the comments of officials from the Pipeline Safety Review Board in the aftermath of the spill to illustrate the argument. Officials' comments revealed the tendency for provincial agencies to act "as the defender of the industry they were initially established to regulate" (2013: 13), rather than as the defender of regulations and laws established to ensure public safety and environmental health.

Regulatory capture is aided by oil and gas lobbying,[53] generally coordinated by the Canadian Association of Petroleum Producers (CAPP). Carter considers the oil and gas lobby to be a significant force of power in the province, calling it "the second major actor in Alberta's petro-political regime" (2010: 16) after government. For Zalik, only in "the context of regulatory capture, … including the interpenetration of provincial governments and industry executives" (2012: 274) can Alberta's extremely low royalty regime (Taylor 2006) and meager sovereign wealth fund be understood (Poelzer 2015).

While the notion of regulatory capture is readily apprehended at a conceptual level, Dal Bó notes that actually measuring capture is "tricky," and so therefore, too is measuring the outcomes of capture (2006: 214). Both regulatory capture and the petro-state help to explain the political economic factors contributing to the suboptimal environmental regulation of hydrocarbon resources at the provincial level, especially greenhouse gas emissions. However, an examination of the role of, and limits to, federal authority in oil resource and GHG emissions is also necessary, insofar as it explains why such political dynamics play out largely at the provincial, rather than federal level. Section 3.2.2 argues that the particulars of Canada's constitutional division of powers offer a multi-level governance explanation for regulatory failures at the provincial and federal government level.

3.2.2 "Passing the Buck": Inter-jurisdictional Regulation of Resources and the Environment in Canada

Understanding how Alberta's oil and gas resources and its environmental pollution issues are managed and regulated, also entails an understanding of how provincial authority interacts with federal authority. According to Hessing, Howlett and Summerville, this institutional order consists

[53] For instance, in 2009, the federal minister with the highest number of recorded contacts with lobbyists was Environment Minister Jim Prentice (who also served as Premier of Alberta until May 2015), the majority of which were with fossil fuel industry representatives (Carter 2010: 17; McGregor 2010).

of two legal regimes: the constitutional order of Canada itself, and the international treaties regime (2005: 59). The Canadian constitution plays a significant role in determining how governments act in response to resource and environmental issues (*ibid.*).

As a federation, state powers and functions in Canada are divided between a central, federal authority. Regional, provincial authorities are considered "sovereign within their established jurisdictions" (Hessing, Howlett and Summerville 2005: 60). The respective roles of the federal and provincial governments have been delimited in Canada's two Constitutions (1867 and 1982), determining which government entity is entitled to make policy decisions about given issues. This is not to say that the division of powers has resulted in clarity about jurisdiction and sovereignty. In fact, as a nation founded as a resource-based colony, perhaps it should be no surprise that, as Hessing, Howlett and Summerville explain, "[r]esource and environmental policy has been a significant locus of federal-provincial struggle, an arena in which power between levels of government may be contested" (*ibid.*).

Prior to 1982, the distribution of federal and provincial authority over natural resources was determined by the *British North America Act* (1867). Sections 92(5) and 92(13) awarded provincial governments the exclusive right to "the management and sale of public land and resources," and property within the province (ibid. 60-1). However, the federal government was granted exclusive powers in trade and commerce, and as such, natural resource issues have "often been debated as a question of the provincial right of ownership versus the federal right to regulate trade and commerce" (Hessing, Howlett and Summerville, 2005: 61).

When the Canadian Constitution was patriated under the 1982 *Constitution Act*, the only change to the constitution with regards to natural resources was the establishment of Section 92a. The creation of Section 92a was created in the context of the political reverberations of 'western

alienation',[54] and essentially reaffirmed previous provincial powers, granting exclusive provincial rights to legislate "non-renewable natural resource exploration, development, conservation and management" (Hessing, Howlett and Summerville 2009: 64).

Scholars such as Harrison (1996) contend that the intersection of the constitutional order and political incentives for regulating the environment account for Canada's well-below average environmental track record. While the *Constitution Act* reforms of 1982 and subsequent court challenges have reaffirmed the jurisdiction of provinces over natural *resources*, in contrast, powers to regulate *environmental* issues, as a distinct set of concerns, were not similarly clarified. And, since almost all regulated human activity (especially resource extraction) has an environmental impact, Harrison contends that powers to regulate the environment are, "liberally sprinkled through the heads of power given to each level of government" (1996: 32). For Hessing, Howlett and Summerville, this has produced a "patchwork response" to environmental issues by federal and provincial governments (2005: 64).

The result is, on the one hand, substantial overlap in federal and provincial *powers* to regulate the environment. For instance, the federal government has several sources of authority on environmental issues, including the power to ensure "Peace, Order and Good Government" ("POGG"), extensive taxation and spending powers, jurisdiction over international and interprovincial trade, and authority over international and interprovincial environmental issues (Bramley et al. 2011: 39). On the other hand, the limits of federal authority on environmental matters are unclear, because federal governments have so rarely tested them (Bramley et al. 2011: 4). As Carter argues, the federal government has taken a "surprisingly limited view of its own environmental powers" (2010: 4), and in most instances, federal governments are hesitant to

[54] This was most formidably exemplified, and exacerbated, by then Prime Minister Pierre Trudeau's National Energy Program, in which the federal government sought more federal control over the energy industry – an aspiration which flew directly in the face of the Alberta Progressive Conservative Party's decade-long campaign to have more provincial influence in federal decision-making (Leadbeater 1984). The NEP episode extended "a long history of alienation from the federal centre – expressed in regional separatism," which Zalik contends was condensed "in particular with regard to its oil resources and the extent to which they have been used by central Canada" (2012: 273).

intervene in development (Vlavianos 2007b: 67; Carter 2010: 16). Therefore, while a federal/provincial jurisdictional overlap exists on paper, in practice there are regulatory gaps, through which federal and provincial governments "pass the buck" to each other (Harrison 1996).

Why does this occur? Harrison argues that the federal government is disincentivized to assume environmental authority because environmental matters are often related to natural resource exploitation issues. As such, any perceived incursions of the federal government on provincial resource matters "are guaranteed to provoke opposition from the provinces, which jealously guard their control of natural resources" (Harrison 2007: 97). This applies to climate and energy issues since, as Harrison explains, "the provinces … control the natural resources most relevant to climate policy," namely emissions-producing resources like oil, gas, and coal, but also hydro-electric potential and forest carbon sinks (2007: 97).

But perhaps the central reason that both government levels avoid taking responsibility for environmental regulations is the diffuse benefits to government of assuming responsibility for environmental protection. In *Passing the Buck* (1996), Harrison argues that it is not so much the structure of the Canadian constitution that prevents federal action on environmental matters, but instead, that the Constitution and "the institution of federalism provides a convenient means of escape from politically challenging environmental responsibilities" (1996: 164). Whereas provincial governments are motivated to defend and maintain jurisdiction over natural resources, which can produce significant revenue streams, environmental matters are generally seen as having "concentrated costs, diffuse benefits," often involving diffuse benefits to the public and concentrated costs (either monetary to either business or taxpayers, or political 'costs') to decision-makers. Harrison therefore characterizes the approach of the federal government to environmental matters as one of blame avoidance (*ibid.*: 18-20), and the role of the cohort of ten provinces as one concerned with competition and capital flight (*ibid.*: 20-24).

So why does action on environmental protection nonetheless sometimes occur? In Harrison's view, this is caused by infrequent moments of heightened public attention to environmental issues, which then compel governments to adopt environmental regulation (such as the creation of endangered species regulation in the early 1990s). As Harrison articulates, both the federal and provincial governments are not simply "blame avoiders" but also "credit seekers" (1996: 7). In the "issue attention cycle" (Downs 1972) with moments of heightened public attention to, and demand for, environmental protection, one should expect to see levels of government seeking "credit" or legitimacy for environmental protection by stepping in and taking an active regulatory role. It should be noted therefore that, "relatively small changes in levels of public awareness can transform the balance of [perceived] political costs and benefits" (*ibid.:* 16). This also means that there is as much need to look at "societal influences on governmental strategies" (*ibid.*: 9) as on government strategies alone. Section 3.4 details some of the ways that such "societal influences" shape government strategies with regards to Alberta's hydrocarbon industry, in particular CCS policy.

Harrison's account also touches on how domestic environmental regulations are conditioned by international environmental negotiations, and global and international political dynamics in general. For instance, in the case of the Kyoto Protocol, Soron that contends Canada's commitments were made "in relation to its broader strategic commitment to an emergent neoliberal trade and investment regime," one which created deepened dependence on the US, and created obstacles (perceived, if not real) to the pursuit of significant emissions reductions (Soron 2004: 344).

3.3 The Regulation of Climate Change in Canada and Alberta

The preceding discussion showed that the division of powers with respect to the environment within Canadian federation is not clear, and the structure of incentives for both levels

of government to act on environmental issues is weak. Such conditions frame the possibilities for the regulation of greenhouse gas emissions in Canada and Alberta, of which this section provides an overview.

There is no clear-cut jurisdiction in Canada for regulating greenhouse gas emissions or mitigating climate change. But both the federal government and a number of provinces have enacted greenhouse gas emission regulations. As early as 1990, only two years after Jim Hanson's presentation to the US Senate 'broke' global warming from a scientific question to a political "matter of concern" (Latour 2004), a Canadian federal-provincial National Action Strategy on Climate Change was formed. This marked the beginning of a decade of federal and provincial government discussions on greenhouse gas emissions, marked by periods of both coordination and contestation (Harrison 2007). The Liberal government of Prime Minister Jean Chrétien faced many challenges to enacting climate change regulation during this period, "from fossil fuel and energy-intensive manufacturing industries, from the federal government departments representing them and from provinces whose economies rely most heavily on those sectors" (Harrison 2007: 100). Yet by November 1997, federal and provincial energy and environment ministers were in agreement that it is was "reasonable" to work to reduce aggregate greenhouse gas emissions to 1990 levels by 2010. This constituted agreement with the principles of the Kyoto Protocol, the 1997 protocol to the United Nations Framework Convention on Climate Change, which required industrialized nations to reduce GHGs by an average of 5.2 percent from 1990s levels by 2008-2012. Nonetheless, there was a long way to travel between general agreement and ratification of the Kyoto Protocol.

A few months after Chrétien announced Canada's intentions to ratify, he established the National Climate Change Process, a joint federal-provincial-territorial process for decision-making on implementation of the Kyoto Protocol that included roundtables with industry, government, and non-governmental organization experts. Alberta, "the province most opposed to action on climate change," was co-chair of the process (David Suzuki Foundation 2005: 2). During talks between the

federal and provincial governments, then federal environment minister, Sheila Copps, recalled, "it became clear that the rule of [federal-provincial] 'consensus' in the environmental agenda would mean moving to the lowest common denominator. There was no way that Alberta would agree to *any* reduction in fossil-fuel emissions" (in Harrison 2007: 101).

Throughout the 1990s, Canadian climate stakeholders were keeping an eye on US developments. The basic negotiating position of federal leaders in climate change negotiations was to closely match the American position. This is based on the rationale that Canada's close economic relationship with the U.S. "sets the boundaries within which Canada must calculate its range of acceptable action" (Broadhead 2001; see also Soron 2004, Harrison 2007, Woynillowicz 2014). This policy stance, strongly advocated by the Canadian Association of Petroleum Producers (CAPP) (Harrison 2007: 109) is still used by bureaucrats and politicians at the federal level, and in Canada's hydrocarbon exploiting provinces today (see Chapter 6), and it was cited as a reason for dampening Alberta's climate goals by several interviewees. And yet the insistence for regulatory harmonization on climate belies the fact that from 2001-2011, the two countries' climate policy paths sharply diverged. In 2001, in his first year as president, George Bush Jr. withdrew the US from Kyoto Protocol negotiations. In contrast, Canada continued towards ratification.

By 2002, whether or not Canada would ratify the United Nations' Kyoto Protocol had become a heated national conversation (exemplified by private letters between CAPP and the Prime Minister (Campanella 2011: 24)). According to Urquhart, once Chrétien made clear it that Canada would ratify, "[l]eading Alberta politicians, as well as some powerful players in the energy sector, railed against Kyoto" (2005: 149). The arguments against Kyoto rested on the arguments that increased energy would be needed to keep the country's economy growing, and that environmental regulations damage economic profits (*ibid.*, MacDonald 2007), both arguments with questionable empirical evidence (see Wiebust 2009, Urquhart 2002a, 2002b for Canadian examples). But Chrétien used his exclusive power to be signatory to international treaties (Hessing, Howlett and

Summerville 2005; Kwasniak 2002), and with a 195 to 77 vote for a motion supporting ratification, in December 2002, was able to negotiate and ratify Canada's commitment to the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCC) (Soron 2004).

So how did the Kyoto Protocol commitment translate to policy pathways and emissions outputs? Despite the Liberal's 2005 *Moving Forward on Climate Change* plan, and the Conservative's 2008 *Turning the Corner* plan, emissions during Canada's Kyoto commitment period (2002-2011) rose steadily, particularly in Alberta, British Columbia, New Brunswick and Saskatchewan (David Suzuki Foundation 2005). Less than five years after ratifying the Kyoto Protocol, it was apparent that Canada would not be able to meet its targets.[55] Canada began to draw sharp criticism both domestically and abroad for its drastic emissions overshoots. As we saw above, in December 2011, Stephen Harper's outspokenly pro-oil minority Conservative Party of Canada announced that Canada would legally withdraw from the Kyoto Protocol (May 2011). Just as the ratification of Kyoto Protocol in the Canadian system relied in part on the relatively powerful executive branch, so too did Stephen Harper's withdrawal from the protocol rely on the same powers.

3.3.1 The Seven(ty)-Percent Solution: CCS and Alberta's Climate Change Strategy

Although the federal government took the first steps in regulating climate change in Canada (and could take a much larger role), provinces have, for their part, also (variously) taken action (David Suzuki Foundation 2005, 2012). Under the provisions of the Constitution, provinces have direct responsibility for managing natural resources, including oil and gas, and also hold jurisdiction over electricity management, two sectors responsible for the largest increases in greenhouse gas emissions since the beginning of the Kyoto commitment period (2005: 3). For their part, provinces and territories have taken a wide range of responses to climate change, with varying

[55] In 2006, by the time Chrétien's government was replaced by Stephen Harper's outspokenly pro-oil minority Conservative Party of Canada, Canada's GHG emissions totaled 721 megatonnes (Mt), nearly a full third (29 percent) above its Kyoto targets (Environment Canada 2010).

combinations of 'talk' and 'action' (see David Suzuki Foundation 2012). Alberta was amongst a group of province and territories which, in the mid-2000s, drafted climate change plans "that pushed back at the federal government, asserting provincial jurisdiction and advocating a "sharing of burden" while taking little responsibility themselves" (David Suzuki Foundation 2005: 1).

The Alberta government's actions with respect to climate change reveal a record on climate change regulation and policy that is decidedly mixed. Overall, the Alberta approach to emissions regulation can be described as a strategic compromise: on the one hand its approach has consisted of push back, stalling, obstruction of cooperation, and at times vocally and vociferously resisted federal regulation of emissions. Yet, Alberta also became the first jurisdiction in the country to regulate greenhouse gas emissions through a pricing mechanism (see below), and has adopted its own "Made-in-Alberta" GHG targets, creating "an expectation that it will take the necessary actions to meet them" (Bramley et al. 2011: 1).

Alberta's first GHG targets were released in October 1998 (*Strategy for Action on Climate Change*), a document containing few concrete actions of commitments (Bramley et al. 2011: 4). In 2002 the government produced a new, detailed climate plan, *Albertans & Climate Change: Taking Action,* while at the same time spending almost $2 million on anti-Kyoto advertising (Bramley et al. 2011, Uruqhart 2005). This plan committed to reduce the province's GHG intensity (emissions per dollar of GDP) by 50 percent between 1990 and 2020.[56] [57]

The plan was widely criticized by environmentalists and others, primarily because reductions were not based on absolute reductions, but rather on reductions in emissions *intensity* – a reduction in the amount of GHGs produced per unit of oil (Leach 2012: 4), thus in no way preventing overall emissions from increasing. The other, more insidious problem with an intensity

[56] This is equivalent to 60 megatonnes (Mt) in annual reductions below business-as-usual (BAU) levels by 2020.
[57] The plan detailed several plans for "carbon management": including a call to start pilot projects and monitoring programs for carbon dioxide for enhanced oil recovery; a "royalty credit" for demonstration projects; and a plan to "[w]ork with other governments to develop protocols for the monitoring of CO2 in stored geologic formations" (Alberta Environment 2002). These plans can be regarded as early instantiations of carbon capture and storage policies.

target, critics argued, was that it took advantage of public perceptions of numerical figures: "By the province's account, Alberta's plan promises reductions in GHG emissions that, to those who take government announcements and information at face value, could be interpreted as far more ambitious than those demanded by Kyoto" (Urquhart 2005). Urquhart called the formulation "doublespeak", since "Alberta's impressive-sounding GHG reduction targets actually called for increases in the tonnage" of emissions released by the province.[58] This action – taking advantage of the public perception of numerical figures – is an important precedent. It is one that was repeated in the 2008 plan, which is explored in detail in Chapter 6.

The plan did not translate into direct regulation of the oil, gas and coal sectors, and by the time a new Conservative government took office in Ottawa in 2006, Alberta had "appeared to cease" its work on regulating industrial GHG emissions (Bramley et al. 2011: 4). However, the following year, in March 2007, the Alberta government announced the *Specified Gas Emitters Regulation*, which placed caps on emissions for large GHG emitters. Bramley et al. saw the regulation as strategic, arguing it could be explained by then Premier Ed Stelmach's desire to "set a provincial precedent" (2011: 4) ahead of the new federal Conservative government's first attempt at detailed regulation of industrial GHG emissions (the now-abandoned *Turning the Corner* plan). As Leach explains,

> "[i]t was felt that the federal government would be unlikely to supersede provincial regulation of GHGs provided that the provincial policies were of similar stringency. As a result, Alberta saw an opportunity to hedge the potential risks from federal policy by developing and implementing a provincial GHG policy before the federal policy was finalized" (2012: 3).

[58] Using an emissions intensity target, emissions would be 39 percent higher in 2010 (the Kyoto mid-point) than in 1990 and in 2020 would be 27 percent higher than 1990 (218 mt, instead of a 171 mt baseline) (Urquhart 2005: 151).

The significance of *Specified Gas Emitters Regulation* (SGER) and its relationship to CCS is elaborated below.

3.3.2 Specified Gas Emitters Regulation

The *Specified Gas Emitters Regulation* (SGER) sets intensity-based targets for all industrial facilities (electricity, oil and gas, and other) emitting more than 100,000 tonnes (0.1 Mt) of CO_2 equivalent per year. Facilities are expected to achieve 12 percent reductions in emissions intensities below a three-year average intensity determined from a measurement period. The regulation is set up such that there are three possible compliance outcomes. Either companies successfully reduce emissions by the specified 12 percent, or else facilities that have gone above their targets have two options: purchase offset credits from other projects within Alberta, or make payments of $15 per tonne into the Climate Change and Emissions Management Fund (see below) (Bramley et al. 2011: 7). Leach notes that the regulation is significant, since facilities covered by the SGER account for roughly half of GHG emissions in Alberta, and since the province contributes a third of Canada's GHG emissions, "the policy applies a carbon price to more than one-sixth of all GHG emissions in the country" (2012: 2).

In many ways the SGER was a pioneering policy: it made Alberta the first jurisdiction in North America to apply a price on greenhouse gas emissions for all large emitters. The regulation came into effect a year before British Columbia's equally pioneering carbon tax was implemented, and before a similar, but less stringent carbon price was introduced in Quebec (Leach 2012: 2). However, as Bramley et al. write, "while a pioneering policy usually requires expenditure of significant political capital, and often influences other jurisdictions, it is not necessarily a good policy" (2011: 12). The SGER has been the subject of "significant criticism" (Leach 2012: 2), centred on three aspects of its design: (1) that it is intensity-based, rather than based on absolute

emissions; (2) that intensity targets set by the SGER "have little relation to the likely emission reductions resulting from it" (Grant et al. 2013: 18) (because the exchanged offset credits are not necessarily attributable to the SGER[59]), and (3) that the price of carbon - $15 per tonne – is widely considered to be too low to translate into anything other than tweaks to the province's rising emissions profile.[60]

3.3.3 CCS Major Initiatives

In January 2008, just one year after it implemented the SGER, the Alberta government released its latest climate change plan, the *Alberta Climate Change Strategy* (which is still the most current climate plan, as of 2015; see Chapter 7). The new plan reiterated the 2002 plan's target to reduce annual emissions by 20 Mt below the business-as-usual level by 2010. The plan recommitted to a 50 percent GHG intensity reduction target from the preceding plan, but extended the target another *thirty* years, from 2020 to 2050. The new plan presented quantified "wedges" of emission reductions, each with a target emission reduction amount (see Figure 3.3). Each of these wedges represented a different approach to reduce emissions: CO_2 capture and storage (CCS), energy conservation and efficiency, and "greening energy production," (which includes both renewable energy *and* measures which reduce the GHG impact of hydrocarbon production). While the plan set both numerical targets and specific policy actions for each wedge, Bramley et al. note that "it does not attempt to show that the policies will be strong enough to achieve each wedge"

[59] This is the problem of "additionality" – a major problem in carbon offsetting schemes, like the UNFCC's Clean Development Mechanism (CDM) (see, for example Lohmann 2010, Schapiro 2010). That is, offset credits are supposed to represent emission reductions in Alberta that would have happened without the offset mechanism (they are 'additional' to business-as-usual). Yet, the Pembina Institute's examination of Alberta's offset registry revealed "that more than 82 per cent of the 10 Mt of credits used for compliance with the SGER during 2008–10 came from projects that started up between January 2002 and January 2007 — that is, before the SGER was unveiled in March 2007" (Grant et al. 2013: 12).

[60] Bramley et al. illustrate the weak incentive this price has on oil sands producers: if oil sands production emits an average 0.11 tonne CO2 per barrel of oil, the incentive to reduce is no more than 20 cents per barrel, or 0.2 percent of the price of oil (0.11 tonne/barrel x 1,500 cents/tonne x 12 percent). Grant et al. argue that SGER as it stands does not fundamentally alter the climate challenge of the oil sands: "simply having climate regulations in place is not enough … Alberta's carbon price on heavy emitters is too weak to provide an incentive for oil sands operators to meaningfully reduce greenhouse gas emissions" (2013: 14).

(2011: 5). The disconnect between the quantified wedges and the policies outlined in the plan, as well as the use of technological "wedges" to display carbon reduction targets are discussed at length in Chapter 6.

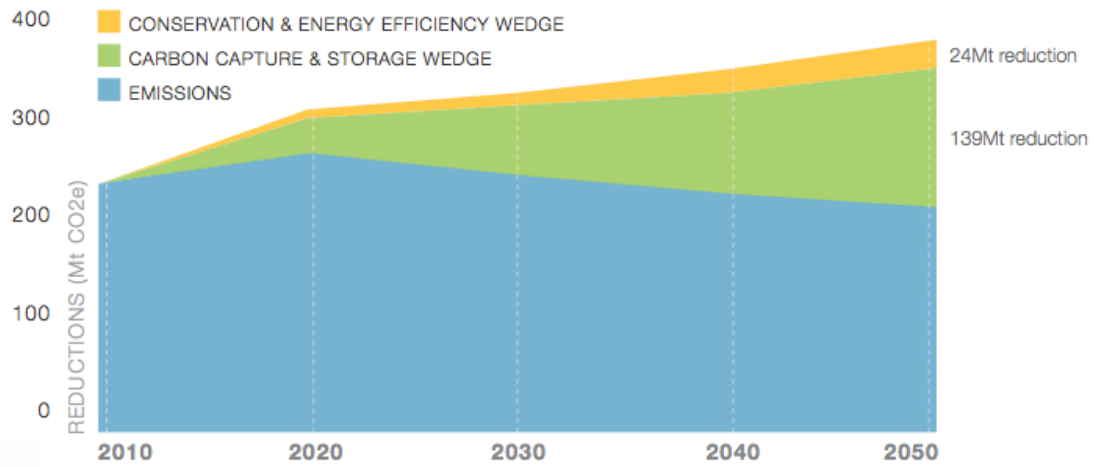

Figure 3.3. *Climate Change Strategy* greenhouse gas reduction wedge.[61]

Of the three "wedges," carbon capture and storage technologies make up 139 Mt of the total 200 Mt reduction target, translating to 70 percent of all planned reductions, and making it the cornerstone of the 2008 plan. Given that CCS accounts for the overwhelming majority of the plan's emissions reductions, the *Strategy* can be understood as a carbon capture and storage plan as much as a climate change plan.

Pursuant to the prominent role of CCS in the *Action Plan,* later that year the Alberta government announced $2 billion in direct funding to advance a "first wave" of commercially viable CCS projects. By 2009, the government had chosen four projects to receive grants totaling $2 billion over a 15-year period (Alberta Energy 2009). The federal government provided the same projects

[61] Government of Alberta 2008: 18.

with $526 million, through its Clean Energy Fund Program (Natural Resources Canada 2013). The four announced projects are described below.

Shell Quest deep saline aquifer storage project is the largest of the four projects, scheduled to receive $745 million. It is being built next to a hydrogen plant at the Scotford upgrader, in "refinery row" in Fort Saskatchewan. Shell broke ground in 2013, and expects to complete the project in the final quarter of 2015. It is expected to store 1 Mt CO_2 equivalent/year, and is the only true "sequestration" project of the four. The second project is Enhance Energy's Alberta Carbon Trunk Line. As an enhanced oil recovery (EOR) project (see Chapter 4, section 4.1), the project, which received $495 million in provincial subsidies, will transport CO_2 from a fertilizer plant to existing "mature" oil fields to be used to re-pressurize wells in order to recover oil. The third project, TransAlta Project Pioneer, was cancelled in 2012 (for reasons explored in Chapter 6). TransAlta Corporation, Canada's largest publicly traded power company, was to receive $436 million investment for Project Pioneer, which would have also used carbon dioxide scrubbed from one of their coal plants for EOR. SwanHills ran the fourth project, which was to be an in-situ coal gasification operation, in which carbon dioxide would be used to convert coal into a synthetic gas known as syngas. By the time it was cancelled in early 2013, SwanHills Synfuels had received part of the $285 million the Government of Alberta had allotted for it.

3.4 Seeking Social License in a Carbon Constrained Future

One of the central questions of this project is to ask how CCS became the primary climate change mitigation instrument of the Alberta government. This directs the researcher to attend to the *practices* of government that form the basis of governing (see Chapter 1). Yet it is also necessary to explore the rationales, motivations and incentives that condition governance practices. The closing section of this chapter explores some of the variables that explain *why* CCS has taken shape

as the central pillar of climate action in Alberta policy. This requires triangulating between official discourses and policy documents, personal and/or unofficial perspectives shared during interviews, and actions taken in the world by relevant actors both within and outside the Alberta CCS community.

Using a geographical political economy framework, I advance the argument that CCS is being pursued by the Alberta government and other allied actors as a technological 'fix' that represents a strategy for addressing Alberta's triple carbon control crisis (climate change, social legitimacy and market access). In the words of Alberta government and industry representatives, CCS is a means of maintaining "social license," which is perceived as necessary to retain market access for their relatively carbon-intensive products. Such an account sees the pursuit of CCS as a strategy of the (political and economic) 'elite,' yet positions the strategy as a response to political demands from civil society.

Both the conventional and unconventional hydrocarbon extraction booms that occurred during the second half of the twentieth century have helped make Alberta a "have" province, in which "[p]rosperity is the subtext, the very spirit, of Alberta public life" (Laird 2005: 156), one in which large quantities of fossil fuel energy have been converted into enormous sums of money (both for the public purse, and for private profit). On the other hand, the liabilities associated with oil-based wealth are manifold. Extensive literature on boom-bust economies has consistently shown the social consequences of resource-dependent economic development, including heightened rates of substance abuse, family strain, gambling, as well as the phenomenon of "golden handcuffs" – where the lure of high paying oil jobs might uproot workers from their communities and other life goals, and 'bind' workers into a high income-high spending (and sometimes high debt) pattern. The province had also seen the social consequences of an "over-heated economy," when uncoordinated boom periods draw in thousands of new workers, creating strain on public infrastructure such as roads, housing and hospitals.

There are also multiple economic risks to "booms, busts and bitumen" (Dobson, Lemphers and Guilbeault 2013). While the early 2000s saw a sprouting of concern about "peak oil" (Bridge 2010), it now appears that while conventional oil may have peaked, unconventional sources like the oil sands have flowed up to replace it. The oil sands boom of the early 2000s staved off a hard question that was coming for Albertans: "what happens when the oil runs out?" Given the estimated size of recoverable reserves, some Albertans might feel there is no reason to worry about the oil running out. Yet the changing face of global energy dynamics is now presenting potentially significant challenges to Alberta's unconventional oil-based economy: "peak demand" in OECD countries (Geman 2009), active "demand destruction" policies (Bridge and Le Billon 2012: 21), including divestments, which stem from climate change concerns about over-abundance of the waste products of fossil fuel combustion, and the replacement of the need for fossil fuels by electrification and renewable energy sources. Many individuals and groups are beginning to see that, in the shadow of anthropogenically-caused dangerous climate change, continued fossil fuel dependence is a human security risk (Dalby 2013), economically threatening, and ethically indefensible. The notions of a 'carbon bubble' and 'stranded assets' – investments in hydrocarbon exploration and projects that would become worthless under a global shift away from fossil fuels – have gained considerable traction over the last two years (Grantham Research Institute on Climate Change and the Environment/Carbon Tracker Initiative 2013), and are becoming mainstreamed in investment and monetary policy circles, particularly in the face of low oil prices (Bank of England 2015, Carbon Tracker Initiative 2014a).[62] Alberta's oil sands reserves, because of their high cost

[62] This is evidenced foremost by the lending of support to the 'carbon bubble' theory by Mark Carney, governor of the Bank of England (and former governor of the Bank of Canada), who has iterated that the "vast majority of reserves are unburnable" if global temperature rises are to be limited to below two degrees Celcius (BusinessGreen 2015; see also Bank of England 2015).

and high carbon intensity, have been particularly singled out as the world most 'unburnable carbon' (McGlade and Ekins 2014, Carbon Tracker Initiative 2014b).[63]

As such, the environmental risks created by Alberta's new unconventional oil boom – high per barrel greenhouse gas emissions, water, land and air impacts – have created an 'unconventional' threat to the economic benefits of the boom: the rapid and massive expansion of oil sands exploitation has created growing opposition from civil society on a number of fronts (LeBillon and Carter 2012: 170). Citizen groups, environmental non-governmental organizations (ENGOs), indigenous groups and nations, scientists, and others have created a cascading constituency of opposition to oil sands development. This opposition has created pressure on governments to stop infrastructure projects that facilitate the expansion of the oil sands, on environmental grounds.[64] Mounting civil society opposition to the oil sands has occurred at least in part because, in the era of unconventional fossil fuels (e.g., oil sands, fracking, arctic drilling), the "long-standing" socio-environmental costs of oil development are made more visible (Bridge and Le Billon 2012: 183), as unconventional extraction involves newer, riskier extraction technologies, often in more ecologically sensitive operating environments. Furthermore, a combination of increasing global level demand and lower quality fuel means that the impacts of oil are getting bigger both per barrel and in absolute terms. In addition, amidst scientific consensus and knowledge of deliberate attempts by the hydrocarbon industry to stall action, "the oil sector has become increasingly implicated in climate change … [and] some NGOs have begun to argue that companies also bear

[63] A January 2015 article in *Nature*, estimated that 35 percent of global petroleum reserves, 52 percent of the global natural gas reserves and 88% of its coal reserves must also remain buried in order to limit planetary warming to 2 degrees Celcius (McGlade and Ekins 2015). Using a model prioritizing social welfare and economic efficiency, the authors found that of all oil-producing countries, "Canada has the lowest utilization of its oil reserves (25 percent), as its natural bitumen deposits remain largely undeveloped," in large part "because it is considerably less economic than other methods of production" (*ibid.*: 189, 190).

[64] This includes, for example, the pressure from various constituencies in British Columbia on Christy Clark to not approve the construction of the Enbridge Northern Gateway pipeline, or the pressure on US president Barack Obama to not approve the Keystone XL pipeline, both of which would carry unrefined bitumen from the oil sands.

responsibility for … the fate of the carbon dioxide and other pollutants produced by fuel combustion" (Bridge and Le Billon 2012).

Public pressure is not just stemming from narrowly 'environmental' concerns: the industry is also being scrutinized on social grounds, as concerns are raised about working conditions, corruption, and more, and as critics develop more totalizing critiques of the unjust and unsustainable social and political formations enabled by oil (Huber 2013, Bridge and Le Billon 2012, Mitchell 2011). In Bridge and Le Billon's view, the oil sector, "is feeling the pressure" (2012: 153) as shown by attempts to respond to stakeholders and citizens on a growing number of fronts. They argue that oil sector actors operate knowing that, "ultimately it is society that grants firms and industries their "license to operate," a license that is conditional on perceived contributions to social goals" (2012: 203). Indeed, the concern for "social license to operate" is the exact terminology used by many interview respondents in this study. For example:

EK: *Why CCS? In terms of Alberta and the world?*

I18: *OK. I think definitely there's the whole climate change impetus … I think that's the underlying principle … that's an altruistic "let's make everybody happy and save our world" kind of thing… from jurisdiction to jurisdiction this is probably similar … Carbon capture and sequestration/storage is also a mechanism to gain social license …especially in jurisdictions that are oil producers, hydrocarbon producers.*

Another respondent made the explicit link between CCS and the pursuit of social license and market access:

I18: *Yah, I hate to keep bringing it up, but I really think that there – the two are tied so closely together – CCS and this whole concept of social license, whatever that may be. But there's no way to avoid bringing it up in almost every instance of CCS…*

For example, Grant et al. contend that the reason behind the creation of the Canadian Oil Sands Innovation Alliance (a group of oil sands producers, government, and academics which works for improvement in environmental performance in oil sands operations) in 2012 was the recognition that unresolved environmental issues in the oil sands "present a challenge to the entire sector's ability to earn and maintain the social license to operate" (2013: 2). In recognition of the threat of poor environmental performance to their social legitimacy, industry players "agreed to collaborate rather than compete in the development and commercialization of environmental technologies, with the intent of leveraging shared resources" (*ibid.*).

The environmental, economic, social and political "acceptability" of oil is, as a result "increasingly in question" (Bridge and Le Billon 2012: 183), a part of what Bridge and Le Billon (2012) call "oil's new reality."[65] For their part, after a period of "hostile opposition to action," the world's oil industry players now feel (and respond to in a variety of ways) pressures to evidence how they are contributing toward climate change mitigation (Boyd et al. 2011: 3, see also Newell and Paterson 1998, 2010, Levy and Egan 2003). This same pressure has also been felt by oil revenue-dependent landlord state governments (in particular in high-income countries), who now, "in addition to addressing the need to reduce domestic carbon emissions, … are increasingly concerned about the carbon intensity of their exports" (Bradshaw 2009: 784).

In a new "carbon constrained world" (ecoENERGY Task Force 2008), the oil industry and beneficiaries like oil states must try to retain and expand markets for their carbon-intensive products while negotiating carbon control measures like carbon pricing, emissions regulations, as well as market sanctions, fossil fuel disinvestment campaigns, government and investor fears of 'carbon liabilities,' the growth of renewable energy, as well as the threat that is inevitable in the medium- to long-run: the burst of the carbon bubble (Bridge and Le Billon 2012: 204).

[65] The "new realities of oil" consist of change to the production network that have evolved in the last twenty years, including increasing price volatility, the re-nationalization of oil, changes in size and location of demand and supply, and the 'energy dilemma' associated with addressing energy security and climate change simultaneously.

Thus concern for continued social license to operate is rooted in the concern to retain markets. I call this concern "export anxiety," which Grant et al. explain thusly: "[i]n a world transitioning toward lower-carbon forms of energy, the higher carbon footprint of oil sands crudes could represent a barrier to trade in some markets" (2013: 4). Since Alberta extracts fossil fuels mainly for export, this "creates an extra and important constituency that cares about what the province is doing about GHGs, and whose displeasure could be a problem: the jurisdictions that buy Alberta's energy" (Bramley et al 2011: 1). For example, the European Union continues to consider the implementation of a Fuel Quality Directive policy, designed to favour lower carbon fuel imports, that would effectively prevent Alberta's oil exports from reaching the EU (Tencer 2014).[66] In a November 2014 speech, former premier Jim Prentice advised that, "Alberta must become a world leader in environmental stewardship or risk being left behind" in the global market (Graveland 2014).

Alberta's petro-alliance is especially cognizant that it is vulnerable to the actions of US jurisdictions, the biggest importers of Canadian oil (Carter 2010: 1). In 2001, when then-premier Ralph Klein told Dick Cheney, "We have energy to burn and we are willing to share…" (cited in Chatsko 2004), the US imported over 650,000 barrels of Canadian oil. Eleven years later, that figure had nearly doubled to over 1,000,000 barrels per year (US Energy Information Administration 2014a). Between October 2013 and February 2014 (latest available data points) Canadian oil made up one third of US imports by country (US Energy Information Administration 2014a), making Canada "the largest supplier, by far, of foreign oil to the United States" (IHS Cambridge Energy Research Associates 2010).

[66] After "what one European official called an "immense" lobbying campaign by the Harper government" (Tencer 2014) in October 2014, it appeared as though the EU was going to drop the FQD rules. But by December 2014, the European Parliament's environment committee voted down the original October decision.

Le Billon and Carter observe that both Canadian Prime Minister Stephen Harper and US President Barack Obama have acknowledged the necessity of reducing their country's emissions, and both have felt the pressure "to implement low-carbon legislation," and that such pressure "has become one of the key challenges to sustained growth in the tar sands" (2012: 171). The Pembina Institute suggests that in the past several years, "oil sands companies have found their access to markets challenged, and their plans to build export pipelines opposed," by groups that are becoming increasingly confrontational in the face of what they perceive as inadequate resolution of their concerns (Grant et al. 2013: 1). As a result, the demand from some American activists for a sustainable, stable and renewable energy supply is now directly and intimately tied to the creation of environmental strategies and regulations on the part of actors in the oil sands.

For Bridge and Le Billon, at the global level, the implications of increased pressure on oil companies to perform better on environmental, social and economic goals is "unclear" (2012: 154), and yet, for our purposes, two implications can be gleaned. First, this increased pressure demonstrates that civil society - NGOs, ENGOS, indigenous groups, scientists and concerned citizens, and others - are a major, if not often directly acknowledged, actor in the story of CCS in Alberta (Levy and Egan 2003; discussed further in the Conclusion). In the global context, Bridge and Le Billon articulate, the new realities of oil and their associated challenges expose an oil "governance deficit" (2012: 182), noting the expanding role of civil society groups in the politics of oil, amidst this deficit (see also Grant et al. 2013:2). Indeed, resistance to the speed and trajectory of hydrocarbon development in Alberta has grown, and "[i]mportantly, both levels of government have been forced to take note of this opposition given the rising media coverage of the issue over the past decade" (LeBillon and Carter 2012: 179). However, taking note of the opposition is not equivalent to acknowledging or taking action based on public pressure, as the distinction between "addressing" and acting on climate change is meant to highlight.

Levy and Egan argue that global climate concerns "present industry with the threat of coordinated international action that could cause serious disruption to markets" (2003: 814). In an analysis of corporate social responsibility and changing US corporate responses over the threat of international negotiations to control emissions of greenhouse gases, they used a Gramscian political framework to argue that corporate political strategy "can be understood as part of the process of conflict and accommodation between business and social groups within particular issue arenas" (2003: 824). For them, a Gramscian approach recognizes the centrality of strategy, and the role of organizations in such strategy. A strategic conception of power can account for actors' ability to work within and to change social structures, "while simultaneously being constructed and constrained by them" (*ibid.:* 813).

The second implication of the increased pressure on oil companies to perform better on environmental, social and economic goals is evidenced by the emergence of state strategies to respond to this pressure (While, Jonas and Gibbs 2010). Le Billon and Carter (2010) identify three state responses to the growing opposition to oil sands exploitation: lobbying, the criminalization of dissent, and ecological modernization. Lobbying includes both the lobbying of provincial and federal governments by private oil interests, and the lobbying of these governments, to other government parties. In trying to defend the "brand" of Alberta oil, "both levels of government have actively promoted and defended tar sands developments" in Washington, D.C., the European Union, and elsewhere (Carter 2010:13). To this end, for over ten years, the Alberta government has maintained a permanent and "lavish" office in Washington, D.C. to promote tar sands investment and imports (Henton 2007, Dembicki 2011a/b). From this office, representatives promote the interests of oil sands development, and defend against policies like California's Low Carbon Fuel Standard (Carter 2010:13).

Le Billon and Carter outline another response, environmental modernization, which they equate to the application of carbon sequestration technology to the tar sands, "a process that

people concerned about the environment and aboriginal people's rights generally see as a public relations exercise and major subsidy for the oil industry" (2010: 1-2). For Le Billon and Carter ecological modernization is equated with a "public relations exercise" (greenwashing), and their dismissal of CCS as merely PR is echoed by other critics, including Greenpeace Canada and the Alberta-based Parkland Institute. But is CCS a greenwashing strategy? Can ecological modernization be equated with, and dismissed as equivalent to, environmental public relations? Is carbon capture and storage simply a more expensive, expansive and technologically mediated PR tactic than a television advertising campaign?

In contrast, I submit that ecological modernization and public relations are two distinct, albeit articulated, moments, and that the distinction has implications for our ability to understand how CCS performs as a political technology. In order to make this claim, I briefly discuss each. First, there is no doubt that, in addition to securing markets through the lobbying and influence, both the Alberta and Canadian governments and members of the oil and gas industry seek to influence American and Canadian polities through public relations and advertising campaigns, and messaging strategies. For example, Enbridge, the company proposing to build a 'Northern Gateway' pipeline transporting unrefined bitumen from the tar sands through British Columbia to Asia-bound ports, has spent millions of dollars promoting the project (Hamilton 2012).[67]

For its part, 'ecological modernization' is a both reformist approach to environmental problems, and a scholarly theory thereof,[68] which "recognizes the structural character of the environmental problematique but none the less assumes that existing political, economic, and

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[67] Another example of a messaging strategy is Ezra Levant's "ethical oil" thesis. In his 2010 book, *Ethical Oil: The case for Canada's Oil Sands*, Levant – an outspoken conservative publisher, broadcaster, columnist, and former tobacco lobbyist, argues that, far from being a socially and environmentally irresponsible product, Canadian oil sands oil is ethical when compared to oil produced in autocratic, or undemocratic nations such as Saudi Arabia, Nigeria, etc., where there are few environmental laws, and some citizens, like women, and homosexuals, enjoy few rights. This argument, however, falls prey to numerous logical fallacies, primarily the false construction of specifically "Canadian" oil against nationalized Others, ignoring the transnational nature of oil companies, as well as the disavowal of human rights and environmental abuses in Canada (not least, for example, the constitutionality of oil sands development on Treaty lands).

[68] Buttel (2000) contends that ecological modernization is indistinct as a social theory; Hajer describes it as at once an analytical approach, a policy strategy and an environmental discourse (Hajer 1995).

social institutions can internalize the care for the environment" (Hajer 1995: 25). For some of its proponents, it asserts the mutuality of business and environmental interests by emphasizing the ecological possibilities of 'enlightened self-interest' (Spaargaren and Mol, 1992; Mol and Spaargaren, 2000; see also Buttel 2000). On the other hand, it emphasizes the role of technological, organizational, and financial resources in achieving environmental improvements, promoting strategies such as flexible market-based measures, partnerships between government and business (Hart 1997, Huber 2004), and the "win-win paradigm" (Levy and Egan 2003: 821, see also Hajer 1995).

In this sense, the pursuit of CCS as a climate change strategy is ecological modernizationist: it assumes "that capital and technology can be deployed to both guarantee energy security and reduce carbon emissions" (Bradshaw 2010:784) by emphasizing the 'win-win' of climate mitigation with continued fossil fuel use. It foregrounds the use of technology to improve ecological conditions, and the approach to CCS taken by the Alberta government relies on preferences for market-based strategies (Alberta Carbon Capture and Storage Development Council 2009: 36). But as the evidence of the work to build CCS as a coherent technological strategy will show (Chapters 4-7), critiques and dismissals of CCS as 'public relations' are partially correct, but also fail to adequately appreciate the complexity, contingency, ambivalence and ultimately frailty of Alberta's particular ecological modernization response to oil sands opposition.

This chapter developed the empirical context for our case study, showing that understanding Alberta as an "energy province" is key to understanding how and why carbon capture and storage is being pursued as a response to climate change. By discussing the broad contours of Alberta's fossil fuel-based economy, and the regulatory context of regulating resources and environmental problems in the Canadian context, I was able to advance the argument that Alberta's fossil fuel energy based political economy is under threat from climate change in the form of a carbon control crisis that includes anxieties on the part of the hydrocarbon industry and

governments of their "social license to operate." I argued that CCS operates as a technological fix to the carbon control crisis. But how does the 'fix' get operationalized? How is the work to secure CCS technology as a strategy for both growth trajectories and environmental improvements actually accomplished? Over the next three chapters, I will show that CCS is constructed as a political technology which 'fixes' goals of addressing climate change with goals of a fossil fuel economy, through the gradual construction of three interconnected, mutually conditioning dimensions, to which I now turn.

Chapter 4: 'The Shock of the Old' – Translations in a Science-Policy Network

"CO_2 capture is just an evolution of technology... CO_2-EOR is nothing new."

– Interviewee I23

"*This is the first massive transfer of interest: scientists have succeeded only insofar as they have couple their fate with industry, and/or that industry has coupled its fate to the state's.*"

- Bruno Latour

4.1 Something Old, Something New, Something Borrowed, Something True: How CCS Comes to Be

From a first glance, it would appear that CCS rose to prominence as a climate change mitigation option in Alberta relatively quickly.[69] The ascent of carbon capture as a GHG abatement technology likewise rose sharply at the international level. Over the course of the last fifteen years, an international community has formed around CCS, expanding "its breath of expertise, its geographic scope and capacity to influence policy" (Stephens and Liu 2012: 127). But how did CCS emerge seemingly so quickly as a climate change mitigation technology? And through what avenues did it come to play a central role in Alberta's climate and energy strategies? The aim of this chapter is to provide a history of CCS technology in Alberta by accounting for the organizations, social networks, and antecedent and analogous technology that developed in order to advance CCS technology.

Chapter 3 presented the argument that, in the face of a mounting need to address climate change, and concerns about fallout from Alberta's high-carbon economy out in terms of legitimacy

[69] In the previous climate change policy, the 2002 *Alberta Climate Change Action Plan*, carbon capture and storage, listed under 'Carbon Management,' received only a fifth of a page, and proposed actions referred only to EOR and CO2 monitoring protocols (Alberta Environment 2002: 3).

and market access, carbon capture and storage technology is being advanced by a proponent community as a 'fix' that helps reconcile continued fossil fuel development and climate change mitigation as competing governance agendas. This chapter will show that a necessary part of understanding how CCS operates as a fix is recognizing that it is being constructed *by* and *on behalf of* a community of actors. This and the following three chapters will show that CCS is constructed as a political technology through the gradual construction of three interconnected, mutually conditioning dimensions (each of these dimensions are separated for the purposes of analytical exposition, but occur contemporaneously):

1. The construction of a new object – CCS. Chapter 4 examines how carbon capture and storage is made for, and made possible by the construction of, a more or less coherent geographically-bound, yet internationally networked, Alberta CCS community.
2. The construction of a network of interested actors, a CCS community, centred around the object. Chapters 4 and 5 describe the constituents of the community and demonstrate how this community is formed in relation to into existing and new networks, particularly the "local" extant hydrocarbon energy network and an emerging "extra-local" community.
3. The construction of new discourses, rationalities and policies about CCS. Chapter 6 examines how this community enjoins the notion of CCS to perform work as a political technology, providing an analysis of the narratives, justifications, rationalities, and scientific practices the community used to produce 'discursive carbon lock-in' of CCS.[70]

[70] Put differently, the next three chapters examine CCS using an old wedding adage. In this chapter, I argue that the CCS community emerged from, and can be roughly mapped onto, prior oil and gas networks - *something old* - where existing expertise in the geotechnical and legal/regulatory aspects of subsurface management provide a knowledge base that can be transferred to a new goal of carbon control - *something borrowed*. Whereas in the following chapter, I focus more extensively on the additional actors that are brought in during the 'institutionalization' phase - *something new*. In Chapter 6, by examining the narratives, rationalities, and story-lines used by the CCS community to advance as CCS agenda, I examine how new truths about the technology are produced, thus, to adjust the adage slightly, I examine how CCS becomes *something 'true.'*

Because these chapters chart a gradual construction, it is necessary to delve into some empirical detail as to how the construction of a new object, a network of associated advocates, and new associated discourses, rationalities and policies about the new object, took shape over time. It is true – and easy to say - that CCS arose as a carbon control measure among a group of well-resourced actors. But in order to fully understand both its momentary prominence and its lackluster outcomes, it is necessary to understand how this group of actors aligned existing and new technologies and techniques, scientific arguments, economic rationalities, political imperatives, policy pathways and regulatory apparatuses, in order to present CCS as the centerpiece of Alberta's climate change strategy. In other words, we need to follow the (long, twisted) path of its emergence, because the devil is in the details: the particular political economy of actors that coalesced, techno-economic arguments made, policy pathways proposed – these account for the success and failure of CCS, at once. Readers should take the empirical details provided in these chapters not as descriptive stuffing, but as the small, yet cumulative, markers of articulations and connections that built a particular carbon control strategy whose components constituted both its pre-dominance within an existing political economic pathway and its susceptibility from exogenous factors.

Chapter 4 will show that CCS is less a 'new technology' that arose as a climate change mitigation option, than an 'old' technology brought to new ends. This occurred step-wise through the collaborative work of industry, research and government actors in response to the emergence of climate change as a major threat to the Alberta/Canadian fossil fuel extractive sector. As this chapter will show, this translation (Chapter 2) occurred over three phases.

In Section 4.2, I show that experimentation with enhanced oil recovery (EOR) technology in the late 1970s and early 1980s established a set of relationships and knowledge networks between actors and institutions, most of which were based on existing oil and gas networks. These would help furnish the networks, knowledge sets and policy basis for the next two stages. In this section I highlight some of the historical analogues between early actions taken in oil and gas technology

research, and those that occurred in the pursuit of CCS. In Section 4.3, I detail how the emergence of climate change as a political and regulatory issue spurred actors working on EOR technology to pursue a new climate mitigation agenda and to proliferate groups and organizations working on these efforts. Here, I highlight how many of the potential problems with implementation of CCS were known early on. I also highlight an often unacknowledged tension in actors' discourse and activities between the goal of *mitigation*, and an obfuscation/elision of whether technology was being pursued for oil recovery or mitigation. In Section 4.4, I show how a now-established group of EOR-CCS experts helped usher in the institutionalization of CCS through regulatory, policy, financial and interpersonal efforts and outputs. I show how successive multi-stakeholder processes lead to a snowballing legitimacy for CCS, and involved the 'wish-listing' of industry preference towards, and through, government practices. Finally, in Section 4.5, I conclude by pointing to the multi-valency of EOR-CCS technology, indicating how this both enabled the successful construction of carbon capture as a measure for carbon control, whilst simultaneously undermining its validity.

My examination of the history and role of CCS in Alberta leads to a central argument of this research: that at each stage in its trajectory, carbon capture technology requires the active support of actors to keep it going, and at each stage it serves as an instrument that produces new ways of conceiving and managing complex ecological, economic, and political issues. This argument is constructed using the notion of 'translation' from actor-network theory, which was introduced in Chapter 2. As such, active support of CCS is maintained to the degree that it enables actors to pursue their interests. By viewing carbon capture in this way, I can account for the both for successes of CCS, but also its challenges and failures.

Campanella's account of the historical development of CCS technology in Alberta productively divides the development of enhanced oil recovery and carbon capture and storage in Alberta into three phases. In the first, carbon capture was being researched and developed exclusively as a means for enhanced fossil fuel recovery. In the second phase, justifications for

carbon capture were reoriented towards framing the technology as a legitimate carbon dioxide reduction strategy. The third phase represented a period of the institutionalization of commitment from the Alberta government to CCS.

Table 4.1 Major organizational actors in the development of EOR, CO_2-EOR and CCS in Alberta.

Phase I – Experimentation with enhanced oil recovery 1980s	- National Energy Board - study potential for CO_2-EOR in Canada - Government of Alberta, Dome Petroleum, TransAlta Power - EOR feasibility study - Alberta Oil Sands Technology Research Authority (AOSTRA) – study on CO_2 streams for enhanced oil recovery
Phase II – New Mitigation Agenda 1991-2010	- Carbon Dioxide Research and Development Network (CORDNET) - Alberta Research Council (ARC) (after 2010, Alberta Innovates – Technology Futures (AITF)) - The National Initiative on CO2 Capture and Storage - Zero Emissions Coal Alliance (ZECA) - Canadian Clean Coal Power Coalition (CCCPC, later Canadian Clean Power Coalition) - Alberta Energy Research Institute (AERI) (after 2010, Alberta Innovates - Energy and Environment Solutions (AI-EES)) - Integrated Carbon Dioxide Network (ICO2N)
Phase III – Institutionalization 2006-2013	- Carbon Dioxide Capture and Storage Technology Roadmap (CCSTRM) - ecoENERGY Carbon Capture and Storage Task Force (EETF) - Alberta Carbon Capture and Storage Development Council (ACCSDC)

My history follows Campanella's closely, because his sequence accurately reflects the historical sequence of the institutionalization of CCS I observed in the province during the course of my research (see Table 4.1). To his analysis, I will add that as the organizational arrangements for carbon capture evolved, so did the technical object itself, moving from EOR in the first phase, to a "CO_2-EOR" quasi-object in the second, and a third phase in which "CCS" becomes a fully fledged, distinct technological concept (albeit with the "CO_2-EOR" still floating as a ghost in the machine). Only by examining the history prior to the provincial government's 2008 *Climate Change* Strategy can it be grasped that CCS is only available as a 'fix' because EOR was already there – available for translation.

4.2 Phase One: EOR and the Origins of CCS in Alberta

In conventional oil production, wells are rarely emptied completely. In a first pass of production, the natural pressure of the previously enclosed formation is sufficient pressure to 'produce' oil – this is called primary production. Yet as more oil is extracted, well pressure naturally drops, and additional means of pressure are needed to continue production. The re-pressurization of wells is called secondary production, and can be done with water flooding and chemical flooding.[71]

Alberta's first major oil boom had taken off in the late 1940s, and thus by the early 1980s, production rates from existing wells were declining after primary and secondary flooding due to de-pressurization:

> I23: *There are a lot of what we will call mature legacy oil pools in the province of Alberta. Where over the years, they have been developed through primary, secondary, and to some respect tertiary development. And what's left now is – the oil that's left underground is much harder to get at.*

While water and hydrocarbon miscible flooding were being used in Alberta, several international oil companies (IOCs) had demonstrated the potential of using carbon dioxide streams as a means of tertiary production during the 1970s in the US Permian basin (Campanella 2011: 9). The application of this technique, known as "enhanced oil recovery" to western Canada's oil producing regions (Alberta and Saskatchewan), became of interest to producers, especially those IOCs also operating in the US mid-west. For instance, drawing from their experience at their west Texas fields, Royal Dutch/Shell introduced CO_2-flooding to one of its ageing wells in southern Saskatchewan Midale reservoir (Campanella 2011: 10). Regulating bodies were also interested, as

[71] Chemical flooding (also known as 'hydrocarbon miscible flooding'), common in Alberta in the late 1970s and 1980s, uses "methane, ethane, propane, butane or a mixture thereof, as solvents that are miscible with oil" (Interviewee I23).

evidenced by a National Energy Board study investigating the potential for CO_2-EOR in Canada (cited in MacIntyre 1986 in Campanella 2011: 10).

However, while the US had naturally occurring carbon dioxide reservoirs (nearly 90% pure CO2 streams) providing "free" CO2 in close geographical proximity to wells, Canadian producers "never had that luxury" (Interviewee I23). Thus while US producers found it cost effective to re-pressurize with carbon dioxide – a nearly free, naturally-formed local input – in Canada it was still most economically efficient to either hydrocarbon flood or to abandon the wells. Nonetheless, in the early 1980s, a few technical studies were conducted, such as a large feasibility study led and funded by the Alberta government, with Dome Petroleum, to capture CO_2 from the TransAlta Sundance coal plant (Campanella 2011, also Legg 1992). This and a line of many other projects[72] showed that carbon capture and storage was at once technically feasible, yet still a net cost to business.

4.2.1 AOSTRA and the Direct Subsidization of Oilsands Technology Development

By the early-1980s, the Alberta Oil Sands Technology Research Authority (AOSTRA) had joined efforts to use fossil fuel and petrochemical CO_2 streams for enhanced oil recovery. AOSTRA was an Alberta crown corporation established in 1974 as part of then Alberta premier Peter Lougheed's '*Project Energy Breakthrough'* (1974) (Ritts 2010: 24), which was aimed at making the regulatory and technological breakthroughs necessary to make Alberta's oil sands reserves

[72] In 1986, both Dome (now Amoco) and Shell partnered with Saskatchewan Energy and Mines for another pilot project to capture CO2 from the nearby Boundary Dam coal plant in Saskatchewan (the same plant that began active full-scale CO2 capture in 2015). The $2.5 million pilot plant demonstrated the technical feasibility of filtering CO_2 emissions from the plant (Wilson et al. 1992), but also that the costs of CO_2 capture were prohibitive for EOR projects (Reeve 2000: 8, Campanella 2011: 10). Other early Canadian projects on carbon capture included an O_2/CO_2 combustion plant in federal laboratories in Ottawa (1994), an amine scrubbing capture pilot plant at the University of Regina in 1995, and a coalbed methane test site at Fenn-Big Valley Alberta in 1997 (see Legg, McDonald and Wilson 2000 for a list of the early history of CO2—EOR in Canada).

economic to exploit. AOSTRA was mandated to support oil sands technology research and to compile and disseminate information on these technologies. Yet, as Ritts contends:

> "This assessment is only half the story. By determining that it have ownership over patents to any new technologies developed through strategic partnerships with industry, the AOSTRA initiative met a double-objective – promoting close working relationships between government and industry while broadening investment within the Alberta economy at the same time" (2010: 24).

AOSTRA's participation in numerous pilot projects for major oil sands projects between 1975 and 1990 exemplifies the first objective of its mandate – strengthening industry-government ties (Alberta Oil Sands and Technology Research Authority 1989: 20).[73] AOSTRA also sought to extend close working relationships with academia, and helped establish a graduate degree in Oil Sands Engineering at the University of Alberta in 1980.

AOSTRA's mandate and activities are noteworthy because it serves as a *historical analogue of governance*, showing five features also shown in the CCS network today.[74] First, by bringing industry and government together to advance a state developmental project (economic feasibility of the oil sands); second, by also incorporating research bodies and academia – a 'third helix' (Ektowitz 2003) of innovation – into the energy resource alliance; and third, by linking (hydro)carbon technology research and development with broader investment and export goals. AOSTRA also demonstrates two additional analogues with the present day CCS community, discussed below.

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[73] This included leading the consortium that developed the steam-assisted gravity drainage (SAGD) oil recovery process (Ritts 2010:24), which is now the dominant oil sands extraction technology, and the leading technology for extracting oil sands deposits too deep for surface mining.

[74] The reference to AOSTRA is not my idea alone. One government representative suggested the comparison is also used within the government: "So in the Alberta structure, you will hear us compare it to AOSTRA… So there's the last time when we invested hundreds of millions of dollars – at that time it was the equivalents of billions of dollars in value, in 1970s money – in a technology, in an effort and a push. […] I think that that's the analogy that people batted around inside of my system" (I27).

Fourth, the modification of CO_2-EOR technology for Western Canadian conditions helped contribute to the development of a 'native,' local pool of carbon storage experts (explored further in Chapter 5), most of whom already had pre-existing oil and gas expertise. Thus, experimentation with CO_2-EOR in the late 1970s and early 1980s established a set of relationships and knowledge networks between actors and institutions, most of which were based on existing oil and gas networks.

And finally, AOSTRA was mandated for "the advancement of relevant environmental research," including the compilation, assessment, and dissemination technical environmental information (Government of Alberta 1974, in Ritts 2010). Yet, as Ritts contends, AOSTRA followed a wider "trend" in Alberta governance operations: to publically promote the environmental dimensions of hydrocarbon RD&D, without concomitant funding and/or follow-up (2010: 25). In their assessment of AOSTRA investments, Hester and Lawrence found that, "despite a clear legislative emphasis on the environment and awareness … of the precise environmental challenges that oil sands presented, AOSTRA spent less than CDN $2 million, or one percent of total funds, on environmental research over the entire 18 years of its operations. In fact, according to the financial accounts, not one dollar was spent on this subject in the first ten years" (2007: 30).[75] Thus, the valorization of (hydro)carbon management technology for environmental benefits, with either a lack of concomitant funding or action, constitutes a fifth analogue that reappears in subsequent carbon capture communities in the province. In fact, this valorization of environmental benefit, to Campanella, demarcates the second phase of EOR-CCS development in the province.

4.3 Phase Two: The New Mitigation Agenda and the Proliferation of Groupings

The emergence of widespread recognition of the problem of "global warming" was ushered

[75] An older study also found that between 1960 and 1980, the period when oil sands operations were first starting, "the combined amount of provincial- industrial money spent on environmental research into oil sands comprised only 1% of the total ($30 million of $3 billion) allocated to oil sands development" (Smith 1981: 110).

in the late-1980s through the testimony of Jim Hansen of NASA before the US House Energy Committee (Levy and Egan 2003: 813). Especially after the establishment of the United Nation Framework Convention on Climate Change (UNFCC) in 1992, both governments and industry alike felt pressure to adopt policies and undertake measures to show demonstrable efforts towards curbing climate change. For it's part, the Canadian federal government began developing a broad environmental plan (the 1990 *Green Plan*). When parts of the draft federal plan, which contained a carbon tax, were leaked to the Business Council on National Issues,[76] "the group rushed to the Prime Minister's Office to object and demand more active consultation" (Campanella 2011: 125; Hoberg and Harrison 1994). By the time the plan was released, it contained neither a carbon tax, nor any other substantial policy commitments (Hoberg and Harrison 1994). We can see that even the earliest government policy formulations on climate change initiated pro-active industrial strategizing on the part of the Canada's largest emitters, including fossil fuel extraction and power generation industries. As Campanella explains, "[t]he perceived risk of demands for large reductions in CO_2 emissions … encouraged members of the fossil fuel industry … to pro-actively seek out potentially acceptable measures" (2011: 12) for mitigating climate change that would not harm the industry's regular rates of profit.

Over the next decade, the climate change mitigation agenda would give EOR a new life: the previously economically unfeasible technology would be advocated for "as a legitimate CO_2 reduction technique" (Campanella 2011: 13). As the chapter will show, the early 1990s until the late 2000s saw the emergence of increasingly coordinated networks and associations of policymakers, decision-makers, scientists and engineers from industry, academia and government, with a small ENGO presence, that operated through associations, conferences, studies and research papers. Many groups formed were themselves ephemeral, but they helped develop an increasingly

[76] Now the Canadian Council of Chief Executives, which includes membership from many of the country's largest hydrocarbon industries (oil and gas, coal, petrochemicals).

coordinated and established case for carbon capture and storage as not only a viable, but also a necessary carbon dioxide mitigation strategy. I detail the work of some of the key groups in the next several sections.

4.3.1 A New Agenda: CORDNET

At a May 1991 workshop sponsored by the Alberta Office of Coal Research and Technology (AOCRT), a consortium of industry representatives, and state research and regulatory agencies formed the Carbon Dioxide Research and Development Network (CORDNET) (Legg 1992: 787-8, Campanella 2011: 13). Members included major coal companies (including TransAlta), oil and gas companies (Nova and Shell Canada), as well as agencies like the Alberta Research Council (see below), Environment Canada, CANMET[77] and others (Campanella 2011: 13, Legg 1992: 787-8). Their goal was to research and develop applications for carbon dioxide capture and storage technologies.

The work of CORDNET-associated researchers was featured prominently in the first international conference on carbon capture, the 1992 First International Conference on Carbon Dioxide Removal, as well as the 1993 follow-up conference, the International Energy Agency (IEA) Carbon Dioxide Disposal Symposium, hosted by the International Energy Agency's GHG Programme (IEA-GHG).[78] The work of CORDNET reveals a number of aspects of the translation of enhanced oil recovery to a carbon control strategy worth noting.

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[77] CANMET is a public-private hydrocarbon research consortium, which includes major Canadian utilities, technology developers, AOSTRA (now Alberta Innovates), and the US Department of Energy (Reeve 2000: 9, in Campanella 2011: 13, fn.8).

[78] The International Greenhouse Gas Control Technology Conference has now been occurring every 2 years since 1992, and the numbers of presenters and participants has increased at each conference. 1077 individuals were involved at the 2010 conference (Stephens et al 2011: 382). Canada's prominent role in the formation of international carbon capture networks was demonstrated by the appointment of Natural Resources Canada's Kelly Thambimuthu to the position of Chairman of the IEA-GHG (Legg, McDonald and Wilson 2002: 1057, Campanella 2011: 17).

First, some of the original research papers[79] resulting from CORDNET studies presented at a 1993 Symposium, and published in a special issue of *Energy Conversion and Management,* demonstrate the close work by industry and state researchers and some of the implications of such.[80] The first implication is the conflation of hydrocarbon interests and state goals (as suggested by the petro-state thesis, Chapter 3), indicated by one article providing a description of the rationale for CORDNET activities, which was co-written by an employee of the Alberta Oil Sands Technology and Research Authority and an employee of TransAlta utilities (a major coal-fired power plant operator):

> "There are good reasons why the capture and disposal option fits the situation in Western Canada. The first and most obvious reason is *the importance of hydrocarbon energy to the regional economy*. Here the economy is based on the production, utilization and sale of hydrocarbons such as coal, oil and natural gas and *we intend to stay in business…*" (Bailey and McDonald 1993: 1146, italics added).

Thus, while the coordination of research activities between industry, state actors and research bodies is a common feature of Western science and engineering practices (Latour 1987), the frank and bald articulation of a unified pursuit of CCS for the protection of hydrocarbon business interests specifically, should be noted. The unity of purpose towards a fossil fuel-based political economy was, as we saw above, already well established before Phase 2. But now we can see that this pre-existing unified goal is what enabled a well-oiled collaborative approach to CCS as a new carbon control strategy.

Secondly, the CORDNET papers in the special edition of *Energy Conversion and Management* showed that the network's efforts entailed not only the rearrangement of technology

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[79] In particular, Bailey and McDonald 1993, Todd and Grand 1993, Vandenhagel, and Miyagishima. 1993, and Padamsay and Railton 1993.

[80] The articles were co-written by employees of AOSTRA and Trans Alta Utilities Corporation, SNC Lavalin and Husky Oil, Mobil Oil Canada and TCA Reservoir Engineering Services (Durango, Colorado), and finally Alberta Oil Sands and Research Authority (AOSTRA) and HBT AGRA Limited (a Calgary-based international environmental engineering firm).

(the tinkering of techniques and tools), but also a discursive rearrangement of the problem of climate change. The paper were technical, but they relied on new rationality – one that rearranged fossil fuels from a problem for climate change, to one in which hydrocarbon production could offer part of the solution to climate change.

Also notable is that the key to the win-win alignment between fossil fuel production and mitigation was the potential of enhanced oil recovery to provide the revenue streams to offset the cost of climate change mitigation. However, another one of the CORDNET articles, by Todd and Grand (1993), found that the practical operating logic of EOR and the goal of climate change mitigation were not always compatible. Their analysis found that it would generally be cheaper for a CO_2-EOR operator to "recycle" its carbon dioxide – easily accomplished by bringing it back to surface, "cleaning" it and re-injecting it - than to purchase fresh carbon dioxide for each flooding cycle. As such, buyers would have incentive to minimize their CO_2 demand, undermining both CO_2 market potential, and emissions mitigation potential. They concluded: "we encounter the conflict between the objectives of high oil recovery and high CO_2 disposal" (Todd and Grand 1993: 1158) (qua emissions mitigation), from both technical and economic standpoints.

Todd and Grant's study, and CORDNET efforts in general, showed that there was a very real difference between carbon capture and storage for oil recovery and carbon capture and storage for GHG mitigation. Although enhanced oil recovery and carbon capture both rely on the nearly the same suite of technologies for capture, transport and subsurface injection of carbon dioxide, as Todd and Grant's study showed, under conventional operating conditions, the incentive structure of EOR is such that the producer will attempt to minimize their carbon dioxide needs, and thus *minimize* the amount of carbon dioxide stored underground. These ends are quite opposite those of carbon capture and storage, where the goal is to *maximize* amounts of stored.

Therefore, the work of successfully 'translating' enhanced oil recovery techniques into sequestration operations would require two strategic changes. The first strategy to successfully

translate EOR into carbon capture and storage was to *make CCS into a new object of regulation*, or a new governable object. In a regulatory environment with no penalty for carbon dioxide pollution,[81] and no financial incentives for emissions avoided, the use of carbon capture and storage techniques for emissions mitigation produces only costs for industry. However, if instruments of policy and regulation, like financial incentives, could be built to offset the cost of CCS to industry, the incentive structure might be changed to make CO_2-EOR revenue/cost net neutral. Such instruments might include the state-funded research support, direct subsidies, or the creation of policies and regulations. This first strategy, of using regulatory and other state mechanisms to render EOR technology into CCS technology by incentivizing activities that lead to mitigation can be thought of as a *translation for mitigation*.

However, Alberta actors have also used another translation strategy, which consists in avoiding differentiating, or 'bait and switching,' EOR and CCS technologies in policy documents and reports. For example, numerous groups concerned with CO_2 capture during the 1990s and 2000s elided making distinctions between the two differing aims of EOR and CCS, or elided detailing the net sequestration achieved if carbon dioxide was sequestered during EOR but subsequent oil recovered from the use of EOR was combusted (Campanella 2011). This can be seen in the four projects announced with the $2 billion subsidy, where only the Shell Quest project was primarily oriented to CCS (see Chapter 1). This second strategy, deployed by actors when the goal is to advance carbon capture and storage technologies in general, without the express purpose of mitigation, can be thought of a *translation by elision*.

Finally, all of the CORDNET papers showed that while capturing and storing potentially large amounts of carbon dioxide was technically and geologically feasible (Bailey and McDonald 1993: 1147), they also all showed that this did not necessarily translate into economic, policy, or political feasibility (Padamsay and Railton 1993: 1174). These two basic facts – technical feasibility

[81] Until the 2007 introduction of the Alberta Specified Gas Emitters Regulation.

and political/economic infeasibility in the absence of a requirement to use the technology, we will see, have plagued the technology throughout its history.[82]

4.3.2 Always Already Applied Research: Alberta Research Council

Another implication of the CORDNET articles was that they demonstrated the ways in which technical feasibility is but a small part of what constitutes the overall feasibility of energy infrastructures and climate mitigation strategies.[83] As such, CORDNET's work demonstrates how, insofar as a large portion of the scientific and technological research carried out on carbon capture and storage in Alberta was 'applied,' many of the studies carried out by scientists and researchers are already thoroughly shot through with economic motivations, rationalities and anticipated outcomes. As Michel Callon has argued, engineers "must permanently combine scientific and technical analyses with sociological analyses" (1987: 100). Thus, research conducted by CORDNET and the other entities described below is always already a political economic-scientific hybrid, and the work of researchers and engineers on CCS is achieved through the intertwining of engineering and economic rationalities.

In the mid-1990s, CORDNET and the Alberta Research Council (ARC)[84] - another provincial government-funded research and development organization - undertook several major studies. ARC's research activities helped Alberta and Canada emerge as a "centre of international research

[82] For instance, one CORDNET paper by Vandenhagel and Miyagishima showed that part of the high cost of capture were troubling energy efficiencies for CO_2 capture efforts, as they demonstrated that approximately *half* of the emissions being captured would be generated by the energy intensive capture process itself (1993: 1155).
[83] This is dealt with in detail in Chapter 6, which discusses in detail the role that ("non-technical") economic, financial, political and policy factors play in determining the outcomes of CCS as a so-called 'technological' fix to climate change.
[84] Formed in 1921, the Alberta Research Council was the first of its kind in Canada: a provincial research and development organization specializing in "converting early stage ideas into marketable technology products and services," primarily in energy, but also in the agriculture/life sciences, forestry and manufacturing sectors (Alberta Innovates – Technology Futures 2014). Over the course of the 20th century, it evolved into an "applied research and development (R&D) corporation," specializing in developing and commercializing technology, but also conducted testing and analysis, technology assessments and demonstration, as well as consultation and policy development.

efforts" into carbon capture and storage (Campanella 2011: 14), such that in the 1990s, many of the CCS leaders at a global level were Canadian.[85]

In one example, a CORDNET/Alberta Research Council study found suitable aquifers for storage, but the proposed projects lacked a "value-adding" CO_2 'utilization' (that is, enhanced oil recovery) stage (Gunter *et al.* 1996). As a result, the lead ARC scientist, Bill Gunter, claimed industry had "no interest in taking the next step a performing a pilot" (in Campanella 2011: 17), and therefore abandoned the project.[86]

It would be a mistake, however, to equate the inclusion of economic rationalities into scientific and engineering work as a reduction of their motivations entirely to economics. For Gunter, the motivation to explore the potential for Alberta as a carbon capture and storage region seemed to based in no small part in the connections he saw between an emergent environmental problem and his own particular hydro-geological expertise. Through my interviews with several of the scientists who worked on CO2-EOR in Phase Two, it was clear that while economic and commercial interests shaped the conditions under which research occurred, it was not necessarily the primary motivator of research. That said, due to their institutional position at government research agencies like the Alberta Research Council, for example, such researchers were able to readily enroll the interests of a larger group of actors, including industry and government, whose interests are more explicitly geared towards revenue and profit. Thus, these scientists were well-positioned to translate their existing expertise in hydrocarbon hydrogeology towards the Alberta's oil patch's new problem: the implications of climate change for continued business.

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[85] This included Stefan Bachu of the Alberta Geological Survey (then later the ERCB and AITF), Malcolm Wilson, of the Petroleum Technology Research Centre in Regina, and Kelly Thambimuthu of Natural Resource Canada (who later went on to become the first chair of the IEA Greenhouse Gas R&D Program), Ernie Perkins (AERI, which later became AI-EES), and ARC's Bill Gunter.

[86] Gunter then shifted attention to studying the potential of using captured carbon dioxide in coal bed methane production, "explicitly rationaliz[ing] the new focus as needing to produce "valuable products" from CO_2 storage" (Campanella 2011: 17).

4.3.3 Scoping and Policy Advocacy: The National Initiative on CO2 Capture and Storage

By the end of the mid-1990s, CORDNET had all but dissolved. However, support for furthering CCS technology remained intact and strengthened (Campanella 2011: 19), especially in the face of the struggle to define Canada's national strategy for the Kyoto Protocol. By 1998, a new group had formed with the goal of "identifying a role" for CO_2 capture in Canada's GHG-reduction actions (Legg, McDonald and Wilson 2000: 1056). The "National Initiative on CO2 Capture and Storage" was a network of more than 80 scientists and "managers" with "balanced representation" from utilities, industry, and provincial and federal governments, with a few representatives from universities, NGOs and actors from outside of Canada (*ibid.*: 1057). Spokespersons Legg, McDonald and Wilson described the "[d]riving force" of the Initiative as tackling Canada's greenhouse gas emissions. Yet they also candidly described the rationale of member participation as "a means of expanding contacts, …a tool in setting corporate research priorities and stimulating collaborative projects, and … [being] available to influence government policies" (*ibid.*). The Initiative emphasized the building of networks with international experts, and encouraged international cooperation with stakeholders and experts from other countries. This open call to collaboration underscores both the prominent place Albertan and Canadian carbon capture proponents played in establishing and maintaining international-level networks, as well as the importance of international actors in developments within Alberta (explored in further depth in Chapter 5).

The "next steps" for CO2-EOR outlined by Legg, McDonald and Wilson included producing "very important product[s]" like "technology pages and Gantt charts to a much more comprehensive and realistic level" (*ibid.*: 1061). As such the Initiative was undertaking the work of establishing the technical legitimacy and feasibility of CO_2 capture and storage as a valid climate

mitigation technique. The construction of devices like Gantt charts acts as an important political technology – a diagrammatic claim on future, as discussed in Chapter 6.

National Initiative representatives participated in the Canadian multi-year Kyoto consultations, the National Climate Change Process (NCCP) (1998-2002), established by the joint ministers at federal and provincial levels to examine Canada's Kyoto implementation options (Environment Canada 2006). Initiative members advocated for the inclusion of CO2-EOR as a legitimate climate change mitigation option at the NCCP (Campanella 2011: 21). One participant in the NCCP recalled that "[i]t was seen by the [oil and gas] industry – and others – as a natural extension to seek additional monetary credit and support [for CO2-EOR projects] through CO_2 emissions reduction credits" (Pendergast, personal communication, in Campanella 2011: 21). Perhaps unsurprisingly then, Canada's First National Climate Change Business Plan, which was released in 2000, figured CO_2 storage as a key research area (Campanella 2011: 21).

The National Initiative can be considered a significant development in the Alberta carbon capture network for a couple of reasons. First, while CORDNET focused on answering (albeit economically conditioned) scientific questions, it did not seek to directly influence policy. The National Initiative, on the other hand, demonstrates an emerging carbon capture community engaged at the level of policy advocacy. Second, it helped mark the early 2000s as the period of the decisive discursive shift from carbon capture technologies as being enhanced oil recovery technologies to being technologies that could mitigate climate change *and* increase oil recovery, at once.

4.3.4 Physical Demonstration: ZECA and the CCPC

The physical demonstrations and pilots of carbon capture conducted in the 1970s and 1980s were directed towards the feasibility of using carbon capture for tertiary well production.

Now, with CO_2 capture and storage technologies beginning to gain credibility as climate change mitigation options, actors began to show a renewed desire for demonstration-scale projects for emissions abatement purposes. Particular impetus came from the coal industry.[87] Both the Zero Emissions Coal Alliance (ZECA) and the Canadian Clean Coal Power Coalition (CCCPC, later renamed to Canadian Clean Power Coalition) were formed for the purpose of pursuing the construction of full-scale CCS-equipped coal plant (Campanella 2011: 22).

ZECA was formed in 2001 through the efforts of Alan Johnson, former president of the Coal Association of Canada (Innovation Alberta 2007a).[88] According to Johnson, "it really was very, very easy to get very significant companies and government entities to work with us to make it happen" (Innovation Alberta 2007a). Yet despite both "international accolades" and similar efforts on the other side of the border, ZECA's "fantasy plant" (Beck 2002) never materialized and produced few results for posterity (Campanella 2011: 23).

The fate of Canadian Clean Power Coalition[89] was similar. The CCPC was formed in 2001 with a commitment to build a full-scale CCS-capture coal demonstration plant, at a cost over $1 billion (Campanella 2011: 23). Yet the work completed by the CCPC to date appears to be entirely feasibility studies, and the website appears to not have been updated in some time (the last study was completed in June 2011) (CCPC 2011). The fate of both ZECA and the CCPC both signal another important feature of contemporary CCS activities, both in Alberta and elsewhere. Chapter 6 discusses in depth how the many 'failures' of groups like ZECA and CCPCC are actually

[87] Coal combustion is the primary mode of electricity generation in both Alberta and neighbouring Saskatchewan.
[88] Johnson was inspired to undertake ZECA after meeting Dr. Zearc of the US Los Alamos National Laboratory. The Los Alamos scientist and his co-inventor, Dr. Klaus Lackner, a geophysicist at Columbia University (Beck 2002), had proposed a theoretical way to turn coal and water into hydrogen and pure carbon dioxide. The idea impressed Johnson enough to bring to Canadian power companies and the federal and Alberta governments.
[89] The CCPC is more strictly an industry group (as opposed to ZECA and many of the organizations formed around CCS-EOR), made up of major Canadian power producers, including coal producers like TransAlta, Capital Power, SaskPower, Sherritt International, and Nova Scotia Power. But its membership also includes North Dakota's Basin Electric Power Cooperative, and Palo Alto, California's Electric Power Research Institute (EPRI). It has received research funding from Natural Resources Canada, Saskatchewan Industry & Resources (SIR), Nova Scotia Department of Natural Resources and the Alberta Energy Research Institute (which is discussed in more detail below).

"demonstrations" in and of themselves: they demonstrate how a misapprehension of the exogenous factors affecting project economics has resulted in a norm of failure for carbon capture projects.

4.3.5 Innovation, of a Different Sort: Alberta Energy Research Institute (AERI)

In 2000, the Alberta Oil Sands Technology Research Authority (AOSTRA) (Section 4.2.1), which had contributed to early studies of EOR in western Canada, was reorganized as a new arm's length provincial government body, the Alberta Energy Research Institute (AERI). AERI's activities and the discourses it produced about these activities provide three points with bearing on our analysis.

First, AERI's mandate reflected an ecological modernizationist approach (Section 3.4), which aimed to further fossil fuel development and improve ecological conditions simultaneously. Yet, these seemed to provide conflicting research priorities with regards to ecological and sectoral commitments. While AERI's mandate was focused on energy technology research, development and demonstration (RD&D), the body also had to follow the lines of the new GHG mitigation agenda. As such, AERI's mandate was broadened to include a new research strategy emphasizing CO_2 management technologies and climate change-related research (Campanella 2011: 25), while still "advancing the interests of the hydrocarbon industry in response to Kyoto-related pressures" (*ibid*.). At base, AERI's priority was the same as the Alberta government's longstanding priority – in it's own words, to "maximiz[e] the value gained from Alberta's natural energy resources" (Alberta Energy Research Institute 2009: 3). And yet, as seen through the work of CORDNET, it was possible to discursively wed this priority to green priorities, especially under the flag of efficiency.[90] The ground-truth of AERI's vision - to help "achieve a prosperous, environmentally sustainable, and diversified energy sector," (2009: 5) - is reflected in its spending priorities. For instance, in 2003-

[90] For instance, one of AERI's key research areas – Improved Recovery – was aimed at increasing production yields from a given well or field, yet it could also be considered an environmental improvement, as maximized yield from a given field reduced the need for new exploration and production (Interviewee I25).

2004, of a total budget of $12 million, $8.7 million was spent on oil sands upgrading and "augmented oil recovery" (EOR), and "greening hydrocarbon production" (CO_2 and emissions; clean carbon/coal), while "alternative energy" (non-fossil fuel energy) received $1.5 million (Laird 2005: 169).

AERI's work exposes what was a deepening tension in Alberta's energy sector between the dominant path dependency of fossil fuel extraction, and an increasing pressure to green energy production. AERI saw that CO2-EOR enabled the possibility that climate concerns and boosts to conventional production rates "could both be addressed with the same tool" (Campanella 2011: 26). This argument – that CCS offered a double bottom line of climate concern and increased returns – was picked up by subsequent groupings.[91] Yet, it is a translation by elision, as elaborated above, that avoids hairy questions about overall net carbon sequestration.

Second, AERI spokespersons Len Bolger and Eddy Isaacs stressed the crucial role of collaboration in the agency's functioning. AERI's objectives were achieved through coordinated research activities with industry and industrial groups like the Petroleum Alliance of Canada (PTAC), the Canadian Oilsands Network for Research and Development (CONRAD) and the Canadian Clean Power Coalition (CCPC) (Canadian Centre for Energy Information 2014), as well as with Natural Resources Canada, many provincial departments, the Canadian Academy of Engineering, and Alberta's two major universities (University of Alberta and University of Calgary).[92] Although AERI worked to provide services to government agencies and universities, in

[91] For AERI, carbon capture and storage technologies not only had the potential to enable GHG mitigation with continued fossil fuel use, but also to *increase* fossil fuel production from the existing infrastructure (Bolger and Isaacs 2003: 59).
[92] University partnerships took several forms, for instance the Coordination of University Research for Synergy and Effectiveness (COURSE), which funded applied research that advanced the hydrocarbon industry, providing results to industry (Campanella 2011: 28), and in 2007, the founding of research chair positions in "Advanced Clean Coal" and "Oil Sands Engineering" at the University of Alberta and the University of Calgary (AERI 2008; Campanella 2011: 28).

2008-2009, for example, nearly three-quarters of total AERI funds were directed to industry (Alberta Energy Research Institute 2009).[93]

Third, AERI's strategic direction, from one of it's annual reports, underscores both the degree to which the triple carbon crisis was experienced as a threat to Alberta's fossil polity, and the degree to which the province's scientific and technical bodies felt their own fates were tied directly to that of the hydrocarbon economy:

> "As strong as it is today, our energy sector faces erosion if we fail to meet the challenges posed to it. The world is changing; *if we resist changing with it, we are risking up to half of our economy*: we entertain a future potentially marked by externally imposed restraints, marginalization, ostracism, boycotts, lost opportunities, reduced standard of living, flight of human and finance capital from the province, and a substantial reduction in the influence we enjoy on the national and international stage" (AERI 2009: 12).

Such a statement is evocative for a scientific research authority, and demonstrates that the carbon control anxieties described in Chapter 3 motivated not only the actions of Alberta's fossil fuel industries, and a hydrocarbon revenue-dependent provincial government, but also deeply shaped state scientific research, development, and demonstration (RD&D) priorities, including the motivation for pursuing CCS.

4.3.6 Mapping the Pathway to Institutionalization: The Alberta Innovates Corporations

In 2010, ARC was reorganized as Alberta Innovates – Technology Futures (AITF), and AERI was rebranded Alberta Innovates — Energy and Environment Solutions (AI-EES) (Alberta

[93] Although ostensibly a quasi-governmental body, AERI's Board was peopled with many high-ranking oil patch veterans, including Eric Newell, former CEO of oil sands giant Syncrude (and chancellor of the University of Alberta 2004 to 2008), and AERI spokesman Bolger himself, an "energy pioneer" (Innovation Alberta 2007b) and senior executive at Shell Canada.

Innovates Energy and Environment Solutions 2014), as part of an overhaul in the organization of the Government of Alberta's "innovation system." Both ARC/AITF as well AERI/AI-EES can be understood as commercial government agencies, a type of para-statal organization. One interviewee who works for AITF explained the relationship to government:

> I36: *Alberta Technology Futures, what we do is essentially the same role as the Alberta Research Council used to do. We're partially government funded. We got about 20% of our funding from government. Ah the other 80% is, comes from client-funded projects. And they could be industry, and it could be government.*

On the one hand, ARC/AITF are partially government funded (including funding from its sister organization AERI/AI-EES) and partially funded through service provision to clients. Yet, governments (whether Alberta government ministries, or the federal government or other provincial governments) are often their biggest clients. The line between service provider and service recipient, however, is not always clean cut in larger projects, with multiple funding sources in play. Two of its main activities have been both "contract research" (Interviewee I36), but also acting as a general research facilitator. This hybrid role is discussed further in Chapter 5.

When AITF was still the Alberta Research Council, it made several important contributions to the "new mitigation agenda" era for carbon capture and storage, including the CANiSTORE and CANiCAP projects. The CANiSTORE and CANiCAP projects, focused on storage and capture, respectively, were carried out by the Alberta Research Council on behalf of Alberta Environment.[94] The significance of these projects is that they each resulted in a 2004 report that outlined 'pathways' to "guide the coordinated efforts of the stakeholders" for geological carbon dioxide storage through pilot and commercial demonstrations (ARC 2004: ii). This practice – of writing joint industry, government and research technology 'pathways' and 'roadmaps' is an established

[94] The impetus for the endeavor stemmed from a May 2003 workshop hosted in Calgary by AERI, Alberta Environment and Natural Resources Canada, where a mandate was established to develop both a governance and technology framework for a "Canadian Network of Innovation in Carbon Geological Storage" (ARC 2004: ii).

practice of Natural Resources Canada that, as we will see, would be repeated in the institutionalization phase (see below). These joint meetings between industry, academic and research groups, and governments are meant to foster "joint decision on future research and development, … and to establish a commitment to work together to address these challenges" (Natural Resources Canada 2014). These practices of collective envisioning might help to promote the orderly development of "critical technologies," but they flatten the real differences in interests between parties.

4.3.7 Writing a Wish List: ICO2N and Industry's Economic Research

One final grouping of actors emerged to play a key role in the nearly two-decade period during which CO_2 capture and removal technology was being translated into climate change mitigation. The Integrated Carbon Dioxide Network (ICO2N), an industry member association, was formed over the course meetings in the summer of 2005 between the hydrocarbon industry and Government of Alberta concerning the large-scale deployment of CCS (Integrated Carbon Dioxide Network 2014). The association was formed to promote the advancement of large-scale CCS deployment in Canada, as well as to conduct in-house research on the technological, economic and policy challenges to deployment.[95] ICO2N's has a current membership of approximately one dozen companies, including oil sands producers, large-scale electricity producers and other energy industry companies. ICO2N has close connections to Suncor, which is the world's largest producer of bitumen.[96]

[95] An international equivalent of ICO2N is the CO2 Capture Project, currently operating with Chevron, Petrobras, Suncor, Shell, BP and Eni as its supporting industry members, and which collaborates with the US, Norwegian and EU governments (Campanella 2011).

[96] Since 2009, Suncor has operated the first commercial oil sands plant to go into production (1967, first built by Great Canadian Oil Sands). Two of ICO2N's three fulltime staff are former Suncor employees (see Alberta Carbon Capture and Storage Development Committee Report 2009: 69,70, below).

ICO2N has advocated strongly for a carbon dioxide pipeline and "integrated" pipeline infrastructure in the industrial heartland of central Alberta (Campanella 2011: 29). ICO2N positions CCS as "vital to the sustainability of Canada's oil sands development and to the continued production and use of Canada's fossil fuel reserves" (ICO2N 2009: 1), and has also argued that CCS is "essential" to a national climate strategy (in Campanella 2011: 29). By framing CCS as vital and essential, ICO2N contributed to an important storyline that marks of the third phase of CCS in Alberta, institutionalization, to which I turn below. Unlike some of the more ephemeral groups formed during the second phase (including CORDNET, ZECA, the National Initiative), ICO2N, along with AI-EES and AITF became players in the next phase of the development of carbon capture and storage in the province.

The second phase of the development of CCS in Alberta saw the (re)formation of oil and gas sector actors who had engaged with enhanced oil recovery technologies around fashioning the technology as a climate change mitigation tool. First agenda-setting, problem-scoping and technical-economic feasibility studies were conducted, exemplified CORDNET, followed by scoping and policy advocacy through efforts like the National Initiative. ZECA and CCPC represented the attempt to translate the new carbon capture for mitigation agenda into physical demonstration plants, but these efforts failed to materialize. There appeared to be at least some lesson-drawing from ZECA and CCPC: subsequent efforts and developments - the reformation of AERI, ARC's work (CANiSTORE and CANiCAP), and the work of ICO2N – can be viewed as "regrouping" strategies that members of the evolving CCS community undertook to identify and address barriers to large-scale deployment.

It needs to be emphasized while the groups formed during the second phase of CCS – CORDNET, CCPC, ZECA, etc. – are distinct in name and vary in their specific purposes, they involve a relatively small set of individual people, and a very small set of companies, research agencies, government agencies. Over the course of the second phase of carbon management in Alberta and

Canada, a number of key developments took place: 1) this time period marked the consolidation of an increasingly coherent CCS networked community; 2) the network became increasingly engaged in policy advocacy; 3) interest in enhanced oil recovery was retained in the mitigation agenda, leaving some uncomfortable potential contradictions in ultimate ends papered over.

4.4 Phase Three: Institutionalizing CCS, Multi-stakeholder Processes, and New Narratives

The third phase in the development of CCS in Alberta is characterized by institutionalization of CCS, marked by the onset of CCS as a prominent, semi-permanent object of research and regulation. This phase is indicated by several developments: the formation of three high-profile multi-stakeholder processes (discussed below); the prominent place of CCS in Alberta's *Climate Change Strategy*, and the large one-time subsidy from federal and provincial governments to build demonstration plants (Chapter 1), and a detailed multi-stakeholder regulatory review process, discussed in Chapter 5.

Three interlinked high-profile multi-stakeholder processes - the Carbon Dioxide Capture and Storage Technology Roadmap (CCSTRM), the ecoENERGY Carbon Capture and Storage Task Force (EETF), and the Alberta Carbon Capture and Storage Development Council (ACCSDC) - were instrumental in advocating for, and helping bring in key institutional and regulatory supports for the development of carbon capture. The CCSTRM focused on the technical aspects of carbon capture and storage, while the EETF focused on regulatory and financial gaps, and "immediate actions" for accelerating implementation, and the ACCSDC focused on more long-term regulatory institutionalization strategies.

As the descriptions below will show, each process made recommendations that fed into the next one, creating a snowball effect of legitimacy, as the recommended technological pathway

suggested an economic pathway, which suggested a regulatory pathway. Since each process was hosted by, and each report published by, the federal or provincial government, each was presented as a vision of the state, even where the main report authors were industry, research or hybrid (see Chapter 5) actors. I refer to this process as policy "wish-listing," which I argue can be considered a form of the "privatization of regulation" noted by Büthe and Mattli (2011). While not as explicit as instances of laws written by corporations, and then adopted by governments, wish-listing points to the role of private interests directly influencing the creation of public policy and regulation.

This happens by being granted the opportunity, through direct solicitation and invitation by government, to make policy and regulatory recommendations in the context of a multi-stakeholder forum. The use of multi-stakeholder forums acts to buffer the perception of policy and regulatory recommendations being made directly by industry. Wish-listing represents an example of the turn to "governance-beyond-the-state" (Swyngedouw 2005), in which participatory governance models are increasingly being used to steer state decisions. Swyngedouw considers governance-beyond-the-state arrangements to be "Janus-faced": one the one hand opening up new possibilities for "participation and articulating the state–civil society relationships in potentially democratising ways" (2005: 1991), while on the other hand often translating into "nonrepresentational forms of autocratic elite technocracy" (*ibid.*: 2003).

4.4.1 The CO2 Capture & Storage Technology Roadmap (CCSTRM)

In 2006, Natural Resources Canada, Alberta Energy Research Institute (AERI) and the Alberta Research Council (ARC) co-led the creation of Carbon Dioxide Capture and Storage Technology Roadmap (CCSTRM), a 90-page report which aimed to help "establish a robust architecture" for addressing the technical, economic costs, and scientific (geological, geotechnical, engineering) aspects of capture and storage (Natural Resources Canada 2006: ii). The report was

the end product of a consultative process involving over 175 individuals from industry, government, research and academic and non-governmental organizations (including a number of international actors) (*ibid.*: 79-80).[97]

The Roadmap identified "critical next steps and champions to facilitate the success of CCS" (*ibid.*: vii), including policy and regulatory frameworks and international collaboration (*ibid.*: 65). For CCSTRM, international collaboration involved staying connected with international activities to help avoid duplication, and to produce higher quality outcomes. Thus, the practice of international collaboration actors had demonstrated since the Phase 1 (see CORDNET) continued as a strong theme into the institutionalization phase.

Second, the Roadmap suggested a policy framework should include both "[a] vision of the role of CCS … among the portfolio of policy options" (*ibid.*: 65), as well as policy "[i]ntegration so that any CCS policy can operate along side (and in unison with) other …policies and measures related to the economy, energy and climate change" (*ibid.*: 66). Both of these recommendations - a 'portfolio' (wedge) approach to Alberta's climate change strategy (discussed in Chapter 6), and policy integration (explored in Chapter 5) – were included in the EETF and ACCSDC reports, and, crucially, were later adopted by the Alberta government. Many other recommendations furnished in the CCSTRM were also were undertaken by the Alberta government over the next five years, for example, the development of supporting legislation (Bills 14 and 24). In most cases, what was a policy recommendation in 2006, in a matter of years, became policy reality.

[97] The CCSTRM Advisory Committee included several "pioneers" of the CO2-EOR RD&D community such as Eddy Isaacs of the Alberta Energy Research Institute, Malcolm Wilson at the University of Regina and Stefan Bachu, then at the Alberta Energy and Utilities Board (*ibid.*: iii-iv).

4.4.2 The ecoENERGY Carbon Capture and Storage Taskforce (EETF) and the Alberta Carbon Capture and Storage Development Council (ACCSDC)

Taking a cue from a central message of the Carbon Capture and Storage Technology Road Map (CCSTRM), in March 2007 the Alberta and Canadian federal governments established the ecoENERGY Task Force (EETF), with a mandate to advise government and industry on ways to collaborate for the purposes of facilitating and supporting the development of carbon capture and storage (CCS) in Canada.[98]

While the CCSTRM was consultative and its Advisory Committee was composed of a mix of industry, government and researchers (most of whom had technical expertise), the EETF was structured as a five-member taskforce, who were mainly business executives (ecoENERGY Task Force 2008).[99] The taskforce was supported by three working groups (Technical, Economic and Policy, and Regulatory and Legal) who represented a veritable 'who's who' from industry,[100] government, academia, and parastatal research entities.[101]

One of the EETF's central recommendations was to establish another multi-stakeholder body that would provide recommendations to accelerate CCS in Alberta. This snowballing wish-listed item was expediently granted by the Alberta, and in April 2008, the Alberta Carbon Capture

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[98] The task force was one of several Government of Canada ecoENERGY initiatives, which included the popular ecoENERGY Retrofit – Homes Program that was terminated in 2012, and a renewable power initiative.

[99] The Taskforce consisted of four high-level executives of major power and petroleum industry players (TransAlta Corporation, SaskPower, Kinder Morgan Canada, Petro-Canada). The fifth taskforce member was Dr. David Keith, an outspoken advocate of CCS for climate change mitigation, of the University of Calgary's Institute for Sustainable Energy, Environment & Economy (ISEEE) (see more in Chapter 5). Dr. Keith is now at Harvard University's School of Engineering and Applied Sciences and the Harvard Kennedy School of Public Policy. Dr. Keith also heads a Calgary-based company, Carbon Engineering, working to develop technology to capture of CO2 from ambient air. He is arguably the most outspoken advocate of carbon capture and storage for climate change mitigation, which has earned him the title of *TimeE* magazine's Heroes of the Environment 2009, as well as a private gift from Bill Gates, but also sharp criticism both some environmentalists and some hydrocarbon industry representatives.

[100] Kathy Sendall (Petro-Canada's senior vice-president), Stephen Kaufman (Director of Business Development at Suncor Energy), Karl Johannson (CVO TransCanada Corp – pipelines), Ian Anderson (Kinder Morgan CEO).

[101] This includes figures such as Stefan Bachu (Alberta Geological Survey, Alberta Energy and Utilities Board, AI-TF), Eddy Isaacs (AERI, AI-EES) and Bill Gunter (ARC), former politician-turned-businessman Jim Dinning, and Malcolm Wilson (Petroleum Technology Research Centre, University of Regina, a "not-for-profit corporation" founded in 1998 by Natural Resources Canada, the Government of Saskatchewan, the University of Regina, and the Saskatchewan Research Council to foster R&D on enhanced oil recovery techniques and carbon storage. Of the twenty-three EETF Working Group members, ten had also been involved in the CCSTRM process.

and Storage Development Council (ACCSDC) was created.[102] There were other direct links between EETF and ACCSDC: one section of the ACCSDC Final Report was entitled "Response to the Canada/Alberta ecoENERGY Carbon Capture and Storage Task Force Recommendations," and directly addressed the 'three immediate actions' suggested by the EETF, explaining how its work addressed such actions.

Two features of the EETF and the ACCSDC hold important bearing on an account of CCS in Alberta. First, the "working group" model is notable because it is later used in the 2011-2012 Regulatory Framework Assessment process. Clearly, this working structure worked well for integrating the viewpoints and expertise of industry, government, researchers, hybrid organizations and others, alike. The working group model allows for the construction of a unified vision of carbon capture and storage.

The second notable feature of the EETF and the ACCSDC are the policy recommendations, or 'wish-listed' items each task force developed. They are significant less for what they contain specifically, and more for the fact that a large portion of the financial and regulatory wish-list items were expediently granted by the provincial government after they were made. All three of the "three immediate actions" (2008: ix) that the Taskforce recommended were adopted by the Alberta Government. For instance, the Taskforce's Immediate Action #1 suggested federal and provincial governments "should allocate $2 billion in new public funding" (2008: ix) to help leverage industry investment in CCS projects. The report was released in January 2008, and by June 2008, the Alberta and Canadian governments had announced a $2 billion investment fund to advance a "first wave" of

[102] The ACCSDC had a slightly different structure to the EETF, and was larger: it had a tripartite structure – a sixteen-member Development Council, a sixteen-member Advisory Group, and three Working Groups, with thirty-six members total. ACCSDC Council members and Advisory Group members (a least seven of whom sat on the EETF Task Force or Expert Working Groups) included deputy ministers of Environment Canada, Natural Resources Canada, Alberta Environment, Alberta Energy, the president of the Canadian Association of Petroleum Producers (CAPP), academics from University of Alberta School of Business and the Institute for Sustainable Energy, Environment and Economy (ISEEE) at University of Calgary, a member of the Alberta legislature, and executives of Syncrude, Penn West Energy, EnCana, Enbridge, Petro-Canada, Nexen, and Suncor. Nine out of the sixteen Council members were from industry. In addition, the ACCSDC also had a roster of official consultants (including several persons who appeared as consultants for one organization, and as Expert Group members under other organizations).

commercial carbon capture and storage projects.[103] Wish-listing in the case of EETF is significant, since out of the three CCS multi-stakeholder processes, it was the one with the highest proportion of industry representation.

In this section, I have detailed the third phase of the development of CCS in Alberta, characterizing it as a phase of institutionalization, where the work of three multi-stakeholder processes help produce CCS as a prominent, semi-permanent object of research and regulation. Beyond the formation of the three high-profile multi-stakeholder processes, this phase is also indicated by the prominent place of CCS in Alberta's *Climate Change Strategy*, the large one-time subsidy from federal and provincial governments to build demonstration plants, and a detailed multi-stakeholder regulatory review process (the Regulatory Framework Assessment), which is discussed in detail in the next chapter. These taskforces were instrumental in furnishing key narratives, rationales and other political technologies that produce what I call a 'discursive carbon lock-in' of carbon capture and storage technologies, an in-depth analysis of which is provided in Chapter 6.

4.5 "The Injection of CO_2 is Not New": Translation and Palimpsest of Enhanced Oil Recovery

We are now able to see that the prominent role of CCS starting from the 2008 *Climate Change Strategy* was only possible because a sizeable network of actors invested in highly CO_2-EOR technology was already established. Thus, a major finding of this chapter is that the CCS

[103] Immediate Action #2 recommended that oil and gas regulators (qua provincial governments) provide regulatory clarity by "quickly confirming legislation and regulation related to pore-space ownership and disposition rights; clearly articulating the terms for the transfer of long-term liability from industry to government" (2008: ix). In 2009 and 2010, the Alberta government passed Bills 14 and 24, specifically addressing the issues of pore-space ownership and transfer of long-term liability with respect to carbon dioxide storage. Immediate Action #3 recommended federal and provincial governments create CCS measurement and crediting protocols so that CCS projects be eligible for emissions credits under the GHG regulatory frameworks to "ensur[e] that any CO_2 credits from CCS are no less tradable or valuable than other credits" (2008: ix). By 2012, Alberta had actually valued CCS project carbon credits such that they were worth *double* the value of other credits (Severson-Baker 2011).

community was not built *de novo*, but instead, was to a large extent mapped onto pre-existing oil and gas associational networks (represented by the state, capital and knowledge production). The success of CCS can be accounted for in part by both the strong industry-government-RD&D links that were 'translated' from oil and gas networks, as well as from the type of expertise CCS community members held, which was conducive to easy transfer from oil and gas to CCS.

This chapter demonstrated that in order to account for the place of carbon capture in the world today, it is necessary to understand how the technology becomes both a product of, and productive of, particular social arrangements. I have established a clearer sense of how carbon capture operate as a political technology (as an instrument that produces new ways of thinking about and managing complex political issues) – by serving as a vehicle that align a series of goals and a common vision among a group of actors with contingently aligned interests. By re-orienting enhanced oil recovery technology towards climate change mitigation, carbon capture became the instrument through which institutional, personal, and state-strategic goals could be, at once, aligned to ongoing priorities of a fossil fuel-based economic trajectory, and newly aligned with the climate change mitigation imperative. It is in this way that carbon capture could begin to function as a fix that demonstrated that Alberta's hydrocarbon polity was addressing climate change.

Through an interview with one scientist, I was able to get a sense of how much and what, exactly, about CCS is new or 'innovative', and just how much constitutes already existing techniques from oil and gas production:

> I8: *CCS has four components. So, first one which is … CO_2 capture at large emitters … As the technology is known today, it is mostly used at gas plants … The second component is transmission … by pipeline, and that technology also … there are thousands of kilometres of pipelines for CO_2… Basically, transmission by pipeline is a non-issue. …The third leg is storage… That is also known and applied technology. It has been used for 40 years now in enhanced oil recovery … The fourth component of the technology is monitoring …*

Monitoring in the deep, using geophysics and other tools – its also old technology… What doesn't exist is integration of the four components of the technology and integration at scale, large commercial scale … So the large-scale integration and large-scale deployment are the technological changes.

The scientist's description of CCS as a four components system of capture, transport, storage and monitoring reveals two important implications. First, in his view, no single technological component of CCS is new. Rather, full/commercial-scale integration and deployment constitutes what is "new" about CCS. This perspective differs from my own assessment of CCS – that what is new about CCS is the application of existing carbon capture and storage technologies towards the purpose of mitigation climate change-causing pollution. My assessment was shared by one respondent who articulated:

I23: *… again, from a regulatory perspective the injection of CO_2 has happened for years, right? … EOR's not new. The injection of CO_2 is not new … What's new is injecting it only for storage purposes. Again, we go back [to]… mass balance. When you're doing EOR mass balance is your friend… The reservoir pressure doesn't really change that much. Right? Molecules in, molecules out. Storage? It's not that way. It's all molecules in, kay? That can create problems … well pressure, and saturation. Those are the unknowns. Those are the "news."*

For this respondent, it is the new *ends* towards which existing technologies are directed – for storage qua GHG mitigation – that constitute what is new about CCS. And yet, they point out that the application of existing technology to these new ends brings about new technological challenges – well pressurization problems, for example, that will in themselves require adjustments to the regulatory regimes that govern the subsurface, explored in the next chapter.

But in this chapter, I also showed that the act of translation was not complete. I demonstrated that though over the course of the 1990s and 2000s, while interest in enhanced oil recovery was translated into the mitigation agenda, it continued to be positioned within discourses, plans and policies for CCS, through a translation of elision. On the one hand this can help account for some of the success and relatively rapid take-off of CCS: the multi-valency of the technology – as an extractive technique (EOR) and/or abatement technique (CCS) - is what enabled the successful construction of a CCS community, willing to advocate for, and enable, the technology. But on the other hand, it means that the palimpsest of EOR remains: it also threatens the validity of CCS technology, both in terms of its overall contribution to GHG mitigation, and in terms of its perceived social value. One respondent expressed the troubling elision that occurs even on the part government of provincial government they work for when they expressed:

> I6: *Because a lot of people call EOR CCS, you know what I mean? Even our government, when we funded three*[104] *CCS projects, two of them are enhanced oil recovery.*

Indeed, as Bäckstrand and Oppenheimer suggest, "infrastructure required for large-scale CCS operations could be seen as a continuation of the existing technological trajectory [EOR], [which] underpins the strengths, but also the potential concerns, with CCS" (2011: 276).

In this way, carbon capture and storage technology can in many ways be considered "the shock of the old," as technology historian Edgerton (2006) describes. For Edgerton, what matters in our conception of technology is not 'invention,' the moment of ideation for a new device or concept, but rather 'innovation,' defined as its utilization and implementation (2006: 4). He argues that often too much emphasis is placed on the moment of invention itself, which for the four component technologies of CCS, was long ago. Instead focus should be directed to the 'struggle of implementation.' This chapter has shown that while the network of actors that coalesced around

[104] The respondent is excluding TransAlta Pioneer from this count, which itself was also an EOR-based project.

the new techno-social object of carbon control that became known as carbon capture and storage were already-allied resource strong actors, there were nonetheless many steps in the struggle of implementing CCS. These included the use of regulatory and other analogues from past work on oil and gas technologies (through translation by mitigation and/or elision), and through wish-listing, and the snowballing of legitimacy through successive multi-stakeholder process. But the path to implementation would also necessitate bringing in additional actors and processes, as the next chapter shows, as well as legitimating discourses and scientific narratives, discussed in Chapter 6.

Chapter 5: Regulatory Framework Assessment - The Composition of a Political Technology

"A dream you dream alone is only a dream. A dream you dream together is a reality."

- Yoko Ono

"There's a lot of players. Each with their own motivations ...it's sort of like the vector sum of a whole bunch."

- Interviewee I35

Thus far our investigation of the development of carbon capture as a carbon control strategy has focused the unfolding trajectory of carbon capture in Alberta. Taking Greenhalgh's cue to examine "particular histories," this chapter adds to our attention to local specificities an examination of how the institutionalization of carbon capture in Alberta has relied on the mobilities of policies and actors beyond the local, as well as beyond the traditional confines of sectors.

In Chapter 2, I argued that national-scale analyses gloss over the relatively high degree of inter-jurisdictional cooperation in carbon capture activities. In this chapter, I draw attention to this form of cooperation and document some of the reasons for it. I also show how most social science analyses miss out on some of the most interesting aspects of carbon capture: the governance of its development 'beyond the state.' Borrowing from Etkowitz (2003), Stephens and Liu describe the carbon capture community as a 'triple helix,' consisting of industry, government and academia (along with a small fourth helix of NGOs), who interact regularly at conferences (2012: 384). While the notion of the 'triple helix' is useful for drawing attention to the fact that the international carbon capture community is composed of representatives from these three sectors, boxing actors into

these categories disguises not only the fuzzy boundaries between them, but also the productive value of these fuzzy boundaries.

The previous chapter showed how CCS was less a 'new' pollution control technology than an 'old' oil and gas technology put to new ends in the face of the threat of the regulation of emissions from the hydrocarbon sector.

A central objective of this chapter is to demonstrate that the advancement carbon capture as a techno-regulatory project entailed not only translating technical expertise and actors from the pre-existing fossil fuel extraction regime; it also relied upon translating existing legal/regulatory expertise, as well as a number of processes of *composition*, as described by Latour (see Chapter 2; Latour 2010, Mosse 2004).

In the context of Alberta, the process of composition can be viewed by examining efforts to institutionalize carbon capture through incorporation into state regulatory regimes and practices. I chose to explore the institutionalization of carbon capture through an up-close exploration of the 2011-2012 Regulatory Framework Assessment (RFA), an multi-expert stakeholder process steered by Alberta Energy. That department sought to address barriers to CCS implementation and to facilitate a regulatory environment conducive to deployment particularly with regards to environment, safety and liability (Alberta Energy 2014b). This process sought to create a 'world-leading' regulatory environment for carbon capture and storage. The RFA figures centrally in the development of CCS as an object of regulation and policy in Alberta. As such, much of my attention during fieldwork was focused on asking interviewees about the Assessment because it is a window through which to understand why and how carbon capture technology "does work" as political technology for the community of actors that support it. This occurs through processes of bureaucratization, knowledge production and through the legitimating functions of expertise.

The Regulatory Framework Assessment is a crystallization of many of the most important dynamics of carbon capture and storage technology examined in this research, illustrating some of

the complexities of the carbon capture community that Stephens and Liu's analysis glosses over: the strong interconnections between carbon capture communities and antecedent hydrocarbon communities, the fuzzy boundaries between government, industry and academia, and the high degree of inter-jurisdictional cooperation and policy 'learning' on carbon capture. I will show that the work carbon capture actors to design a socio-technical support network around carbon capture is as key to its success or failure as the pipes, cap rocks and flue gas separators that make up the technology. By registering some of the geographical and socio-institutional dimensions of this network, one can better understand contemporary ways in which the climate is managed as an object of regulation and knowledge. The chapter presents several such dimensions, highlighted by the Regulatory Framework Assessment process.

The first reason to closely examine the RFA is that it represents a key moment in the bureaucratization of carbon capture activities. The day-to-day of the RFA involved teleconferences, subcommittee meetings, discussions about fine technical details, and a lot of pencil pushing – hardly the most gripping aspects of modern state power and political intrigue. In chapter 2, the work of Kuus and others showed an understanding of bureaucratic processes is key to understanding the bigger, 'sexier' geopolitical issues they generate. Section 5.1 introduces how the RFA exemplified composition in action; because acts of composition occurred through these detailed and "painfully iterative" (in the words of one of my respondents) processes, this chapter covers the Regulatory Framework Assessment in detail. These details constitute what is analytically significant about the process.

Second, as I will show in Section 5.2, the purpose of the RFA was to corral existing expertise on carbon capture in order to produce a 'world class' carbon capture regulatory regime for Alberta. I first present the discourses about Alberta's CCS strategy relayed through media and my interviews, reserving my critical analysis for later in the chapter. The participation of extra-local experts in the RFA process demonstrates the ways in which the pursuit of carbon capture is tied in

with contemporary dynamics of place competition and the 'entrepreneurial turn' in governance. I also show how not only existing technical expertise, but also existing legal/regulatory expertise and practices are also transferred from existing oil and gas regimes. This adds support to my argument that the quest to pursue 'world class' carbon capture regulation reflects a strategy to build off pre-existing strengths.

In Section 5.3, I examine three socio-institutional dimensions of the carbon capture technological fix illustrated by the RFA. I also explore the reasons for, and implications of, the inclusion of individuals and organizations from outside of Alberta as a key component of the government's 'world-class' efforts, analyzing the RFA process as a specific instance of a broader process of the transnationalization of regulation and expertise.

Lastly, an examination of the participants in the RFA serves as a window to more closely examine the constitution of the 'triple helix' of government, industry and research that co-constitute carbon capture as a techno-discursive object. In Section 5.4, I discuss how analyses of carbon capture need to be refined to register the intersections, revolving doors and hybridities between sectors, at an institutional and at the level of individual actors. I detail how the effort to advance carbon capture involves not only the co-production of science, state and economy (Jasanoff 2004), but also relies on, and produces, hybrid expert subjectivities (Larner and Laurie 2010), whose flows and trajectories both 'inside' and 'outside' the boundaries of the state allow an understanding of how contemporary governance and regulation has shifted beyond, but is still thoroughly anchored to, the state.

5.1 Regulatory Framework Assessment Composition and Structure

At the end of Chapter 4, I showed that the Alberta Carbon Capture and Storage Development Council recommended several ways to institutionalize CCS, including passing supporting legislation

and providing large direct subsidies for the funding of demonstration projects. In 2009, the Alberta Legislature passed Bill 14, the *Carbon Capture and Storage Funding Act*, whose purpose was to "encourage and expedite the design, construction and operation of carbon capture and storage projects in Alberta" (Province of Alberta 2009). The small 2-page Act made provisions for the $2 billion provincial CSS direct subsidy, which provided the funding for the first-wave demonstration projects.

In 2010, the more substantial Bill 24, the *Carbon Capture and Storage Statutes Amendment Act*, was passed. This Act served to amend the existing *Oil and Gas Conservation Act* and related environmental legislation in relation to carbon capture and storage. It also clarified property rights around CCS, specifically "pore space ownership" of the microscopic spaces into which the sequestered carbon dioxide is injected. The Act also created a "post-closure stewardship fund," and addressed the allocation of long-term liability of sequestrated CO2, whereby liability for CO_2 sequestration sites would be transferred from industry to the Government of Alberta. According to an analysis by major Canadian business law firm, Blake's, the Act represented "one of the first formalized attempts in North America to regulate CCS" (Averbach, Flynn and Harer 2010), and thus helped position Alberta among the world leaders in carbon capture and storage.[105]

If the regulation of an object, in part, helps constitutes the object itself (Foucault 1977, Bingham and Lavau 2012), an analysis of how carbon capture developed as a political technology necessitates an investigation of the terms and conditions under which it is be socially and legally recognized. As such, Bills 14 and 24 were represented a key moment in the institutionalization of CCS in Alberta, and the constitution of CCS as a distinct socio-technical entity. While these bills provided an initial round of regulatory reform for expedited deployment of CCS, many "regulatory barriers" in the form of regulatory gaps and uncertainty about the applicability of existing

[105] In 2011, a further piece of regulation, the "Carbon Sequestration Tenure Regulation," was passed. This regulation established processes for lease rights in order for companies to evaluate sites for potential CO2 storage.

regulations to CCS, remained. As one interviewee explained, even though Bills 14 and 24 were passed as pieces of legislation, they had yet to be operationalized as specific regulations:

> I9: *... So once this fundamental legislation was in place, then there's a myriad of regulations that need to be written to support. The legislation in and of itself, just gives you the framework. It doesn't give you the details. So Alberta embarked on this process. Which was a hugely ambitious task... to sort out what the regulations should look like, and it was probably over a hundred volunteers engaged in developing those regulations.*

The process to which the interviewee refers, the Regulatory Framework Assessment, was indeed a very ambitious task. And as the interviewee articulated, the task was to develop the fine-grained regulatory details that would enable Alberta to help realize and constitute a new technology. Why was this fine detail needed? As one provincial government respondent articulated, industry prefers operating in contexts of regulatory certainty,[106] therefore the GoA was motivated to eliminate regulatory gaps and add regulatory detail in order to facilitate industry participation:

> I3: *We realized that we ...have to make sure our policies don't hinder the implementation of these projects. And how can we even give industry the regulatory certainly that incents them do to CCS? ... So we have our tenure regulation, our statutes amendment act that ... give[s] government ownership of pore space. [...] So we made some of those big policy decisions right off the bat: pore space and liability, closure plans, that sort of stuff. But we realized if we wanted CCS to take off, we had to make sure all that all the regulatory gaps are closed.*

From March 2011 to December 2012, Alberta Energy undertook the Regulatory Framework Assessment (RFA), in order to address these barriers, and to facilitate a regulatory environment conducive to CCS deployment (Alberta Energy 2014b), particularly environmental, safety and

[106] A sentiment expressed in many interviews by industry and government respondents.

liability dimensions. I was able to speak to over a dozen individuals who had been actively involved in the RFA process. One interviewee was able to speak at length about the reasons for undertaking the RFA, which again, related to satisfying concerns of would-be industry operators of CCS facilities:

> I27: *Back in 2008, Alberta made the decision to invest the money, and industry came to [the government] and said "That's great", and we ran this long process that saw 50 companies – 51 – come forward and say, "We've have projects you should invest in." Outside of the economic and technical hurdles, they said, "Here are the policy issues you need to address for us to us to make our final investment decisions." And they gave us a list of them. Number one and two on everybody's list was related to long term liability and pore space… We said, "We can do these two right now. The rest we'll get to." That's what the RFA is. We are now getting to the rest of this laundry list…*

The interviewee added that the Assessment entailed an international effort:

> I27: *And the RFA is an international effort designed to really identify and address sort of the last twenty or 25 key policy or operational barriers facing CCS.*

Indeed, the Regulatory Framework Assessment process involved the participation of "more than 100 experts, including international experts and representatives from industry, environmental groups, scholars and government" (Alberta Energy 2014b). It used the same tripartite structure as the multi-stakeholder processes described in the last chapter, with a twenty-four member Steering Committee, a five member Expert Panel, and four Working Groups. The Steering Committee was charged with oversight of the process: it guided the scope of the review and the work of the working groups, consulted with the Expert Panel, and approved Working Group recommendations that would then be provided to the Minister of Energy for consideration and decision (Alberta Energy 2014b).[107] The five-member Expert Panel was charged with providing advice and peer

[107] The Steering Committee was chaired by Jim Ellis, Deputy Minister of Energy, and its 24 members represented a mix of government, industry, and non-government organizations, including academics and international organizations (Alberta

review findings to both the Steering Committee and Working Groups on the scope and content of the review. The Expert Panel consisted of "internationally-recognized engineers and scientists in CCS and related fields" (Alberta Energy 2014b).[108]

For their part, the four Working Groups were tasked with developing recommendations for the steering committee's consideration (Government of Alberta 2011). The four working groups were – Measuring, Monitoring and Verification (MMV), Regulatory, Geology/Technical, and Environmental – and each included members from government, industry, academia/research community and non-governmental organizations. According to an interviewee, the Working Groups did the legwork in devising the recommendations, which were then passed up to Expert Panel in an iterative process:

> I27: *We've got the four …Working Groups … giving advice to the Expert Panel … So we come up with clever ideas and wisdom that gets bounced back and forth. So the Expert Panel rips it apart. They say: "You missed what the Chinese are doing on this issue. Go back and do this again." Lots of back and forth. When they sign off on something, it goes to [the] Steering Committee… which again is chaired by [the] Deputy [Minister of Energy].*[109] *They review and approve the recommendations… Or not. They've kicked some down. They've shut some down. But for the most part we've done a good process of making sure that information should be approved.*

Energy 2014b). The Committee also included Jim Carter, who was Chairman of the ACCSD and former CEO of Syncrude, Dr. Stefan Bachu, a 'pioneer' of CCS-EOR both locally and globally, and a recipient of a 2007 Nobel Peace Prize for the work he co-author for the IPCC's 2005 Special Report on Carbon Capture and Storage, and Don Thompson, retired Syncrude Canada Ltd. Executive and Past President of the Oil Sands Developers Group (and ACCSDC Advisory Group member), the latter two whom were also on the Expert Panel as co-chairs.

[108] This included three international experts – Dr. Peter Cook, Chief Executive of the Australian-government funded Co-operative Research Centre for Greenhouse Gas Technologies (CO2CRC), Dr. Andrew Chadwick, head of CO2 Storage at the British Geological Survey, and Dr. Edward S. Rubin, professor of mechanical engineering at Carnegie Mellon University, one of the intellectual 'nerve centres' of CCS. But it also included two Alberta-based individuals who were also on the Steering Committee: Dr. Stefan Bachu and Don Thompson (see above).

[109] The Deputy minister for any given Alberta government ministry is the head of that Ministry.

While the structure of the RFA was similar to the ACCDSC process, a key difference was that the group's work ultimately had to pass to the provincial Minster of Energy for consideration and approval. As such, Alberta Energy was the leader and coordinator of the RFA process, and CCS initiatives overall within the province. For this reason, Alberta Energy was well represented on the Steering Committee.[110]

The 17-month process resulted in a document, *Carbon Capture & Storage: Summary Report of the Regulatory Framework Assessment* (Alberta Energy 2013), which contained 71 recommendations providing direction to the Government of Alberta and relevant units:

> I7: *Recommendations came out of the RFA that are recommendations for [Alberta] Environment to do things, or recommendations for the ERCB [Energy Resources Conservation Board] to do things … But when it comes down to actually implementing them, ultimately they will have the final say on whether or not they implement them or don't... But we [Alberta Energy] still have a leadership role in terms of saying "Hey, you know, we did a multi-stakeholder process that said you should do this. You really should do this unless you have a really good reason not to."*

Thus the RFA did not result in the implementation of any new regulation, but rather laid out recommendations. However, as of mid-2015, the Government of Alberta has not released any implementation plans, and no additional pieces of legislation concerning CCS have been passed since 2011.

According to many of the interviewees I spoke with, the RFA process was, as the respondent indicated above, a "hugely ambitious task" that took a large number of money and person hours:

> EK: *… And it's iterative?*

[110] In the working groups – almost a quarter of the 118 working group participants were from Alberta Energy (n=28; 23.7%).

I27: *it's been painfully iterative [...] because the bouncing back and forth has caused no end of grief. In a good way – better outcomes. But in the process-wise, we're trying to manage people in their process. And it's been exhausting. This has been eighteen months, several million dollars and ... I think eight or ten full-time people on my team who are on this ... It's a huge effort for us.*

For the Working Groups charged with initiating work streams the RFA was a huge data collection and integration effort, a composition of professional opinions, best practices and consultant reports:

I27: *Those twelve or fifteen people per Working Group are doing ... the global scan or the e-scanning. They're looking at best practices in Alberta, and Canada, and abroad. They're hiring consultants if they want to. They're bringing in or leveraging their own institutional expertise and bringing it to the table. And they're trying to integrate and coming up with advice, based on all these complex social, economic and technical challenges.*

As the next section will show, a huge amount of the effort that went to the RFA was in looking for 'best practices' around the globe, not just to gather the best information and practices from around the world, but also in order to become the best in the world.

5.2 Head Start in the Race to the Top: Composing a 'World-class' Regulatory System

In pursuing the RFA, the goal for Alberta Energy was twofold: first, to review existing provincial regulations relating to CCS and recommending any necessary regulatory changes, in order to create a coherent regulatory system for CCS. Second, was to discover regulatory

frameworks, regulatory support and ''technology roadmaps'' for CCS from other jurisdictions in the world.[111]

Yet Alberta Energy did not simply want to adopt best practices; it had a further goal – that the Regulatory Framework Assessment process would result in the creation of a "world-class regulatory system" (Government of Alberta 2011), such that Alberta's regulatory system become "the gold standard for carbon capture and storage regulations" (Alberta Government 2014b). This was not the first time that, couched in the language of international competitiveness, Alberta CCS actors sought to position themselves as world experts.[112] This section will show how the Government of Alberta's deployed the RFA process to operate as a form of self-promotion, or mitigation against the negative claims about the rigour of its environmental performance.

The pressure on jurisdictions to be "world leaders," and to act as examples of "best practice" is a phenomenon that has now been explored extensively by urban and economic geographers. According to these scholars, the ascendancy of neoliberalism within industrialized countries has led to changes in government and governance priorities that help to foster a new normal of inter-jurisdictional competition.[113] The result of the general, if uneven, neoliberalization of institutional and state forms has been, on the one hand the emergence and increasing prominence of new institutional forms and coalitions such a public-private partnerships, quasi-non-governmental organizations and privatized service provision bodies (discussed below in this chapter), and on the other, increased place competition between localities (Cox and Mair 1988).

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[111] The EU ACCSEPT project, for example, was the first comprehensive assessment of the regulatory, economic, scientific, social and legal aspects of CCS (Bäckstrand et al. 2011: 277). The International Energy Agency's CCS technology roadmap (IEA 2009) and World Resource Institute's guidelines to policymakers (Forbes et al. 2010) were available to serve as "best practices" in the regulatory aspects of CCS projects. Bäckstrand et al. (2011: 277) also note the expanding literature on designing appropriate legal and regulatory frameworks for CCS.

[112] The same goal was expressed in the final documents of the EcoENERGY Taskforce and Alberta Carbon Capture and Storage Development Council final documents (EETF 2008: v, ACCSDC 2009: 7).

[113] More so a loose paradigm than a political program, neoliberalism is underpinned by the belief that "open, competitive, and unregulated markets, liberated from all forms of state interference, represent the optimal mechanism for economic development" (Brenner and Theodore 2002: 2). According to Peck and Tickell, neoliberalism "combines a commitment to the extension of markets and logics of competitiveness with... aggressive forms of state downsizing, austerity financing, and public-service "reform"" (2002a: 381); thus the general framework of competition between firms assumed in neoclassical economics is generalized and extended into the state and governance realm.

Place competition has been most extensively studied in the context of the urban scale - the "entrepreneurial city" (Harvey 1989, Jessop and Sum 2000, Peck and Tickell 2002a/b). But sub-national regions and nation states too, have re-structured governance around "international competitiveness, socio-technical innovation, … and new forms of partnerships and networks" (Raco 2005: 327). This includes strategies of "policy boosterism," like the RFA, in which policies and regulations themselves become objects of inter-jurisdiction competition (McCann 2013).

The general shift in policy moved from inward looking service provision to an outward-focused "extrospective" (McCann 2013) emphasis on speculation and the attraction of investment from outside capital and governance bodies. As such, many jurisdictions now base their policy choices and political stakes on an understanding of the international system as one where individual jurisdictions are "driven to vie with each other for first place" (McCann 2004: 1913). With this understanding, according to Peck and Tickell (2002a: 394), jurisdictions "must actively – and responsively – scan the horizon for investment and promotion opportunities, monitoring "competitors" and emulating "best practices," lest they, as the understanding goes, be left behind in "intensifying competitive struggle[s]"" for resources, jobs, or in the case of Alberta, markets.

The question then becomes what does first place look like, and how it is determined? According to Peck and Tickell, some races for first place constitute "races to the bottom" (2002a: 396), involving regulatory undercutting and state downsizing, resulting in, for example, lowered wages and a more lax regulatory environment. Other inter-jurisdictional races, such as the desire to be a model of best practice, are "races to the top," which involve raising the bar in terms of environmental, social or fiscal performance, although often in a piecemeal, strategically selective manner (see Jessop 2002 in Chapter 2), or at the expense of more holistic measures of quality of life, or good practice. The Regulatory Framework Assessment process can be viewed as a race to the top, which involved an outward-looking review process aimed at importing a large quantity of expert and expertise in order be able to brand "world class" status.

One government employee respondent suggested that although the Alberta government regularly coordinates stakeholder engagements with respect to resource issues, the scale, scope (international) and, crucially, purpose of the RFA was different – unprecedented in ambition, and in terms of the spotlight it put on the province:

> I14: *When we think about our typical approach to some of these things, ... And the thoroughness of it going through, "What does our regulatory system, overall, have to offer?" Right? ... "How does it interact with the regulatory system in place?" was a fascinating approach to take, because – and very novel – approach to take because we hadn't done that before.*

Another respondent echoed the sentiment that the RFA was unprecedented in many ways:

> I3: *So that's when we embarked on ... a HUGE effort. Which I think is really rare ... for a government do to – especially a conservative government in Alberta – is that we engaged over 100 stakeholders from around the world, to say "Hey. Everybody look at what we have currently for our regulations. And tell us if they're good enough." [...] So it was ... quite astounding – that the government decided to do it that way [...] We're involved in a lot of international efforts that are more collaborative but I can't personally think of any time when there was a spotlight on Alberta and everybody from the world was looking at us.*

This spotlight, of course, given the aim to be world-class, was a desired outcome of the process. As much as the RFA process facilitated "international scrutiny," in the respondent's words, of Alberta's existing regulatory system for CCS, it also helped to deflect international scrutiny of another kind – Alberta's poor environmental image in the international arena (Chapter 3). Creating a world-leading regulatory system is a crucial dimension of pursuing CCS as a techno-discursive fix for the addressing the province's poor environmental image.

In interviews, I asked respondents if Alberta was a world leader with respect to CCS. Several respondents presented the view that Canada as a whole is a leader in number of both dollars invested and number of projects per capita. Most respondents, when asked if and in what way Alberta was a leader in CCS, suggested that it was a leader in terms of policy and regulation:

> I31: *[Alberta has] probably the most complete set of CCS regulations – or regulatory framework anywhere in the world…*

One respondent echoed this, but also added that is was also a leader in terms of prior investments in the scientific and technological aspects of CCS:

> I18: *… I would have to … that Alberta is a leader both in policy and technology… the province has needed to invest into it from a policy and scientific … perspective, so definitely a leader.*

This emphasis on prior investment is a key part in understanding Alberta's CCS leadership role, as I explain see shortly. One respondent illustrated why they thought Alberta was a leader in terms of legal and regulatory support for CCS:

> I8: *… I think that Alberta is the most advanced jurisdiction in the world in terms of creating the legal and regulatory framework for CCS. … Most jurisdictions… never paid attention to the pore space… So Alberta now has legislation by which the pore space belongs to the Crown … So Alberta has now the legislative tools to give tenure to companies… And the Alberta government passed legislation by which the government is taking liability … So what I'm telling to my best knowledge, Alberta is the most advanced jurisdiction in the world in putting in place… the legal/regulatory, political/legal/regulatory framework.*

When I suggested most people say Alberta is leading in terms of policy and regulatory support, one individual also added that,

> I31: *…so I might choose a bit differently … I think Alberta's leading in deployment. Right? Like full systems deployment. And I don't want to say leading. I mean that's other areas in the world doing this. But there aren't areas that enable… them to put all the pieces together right? So that's' really where the advantage is… So it's not just the fact that the government committed funds. It's that they actually set up a plan. And yah, it had some warts, but actually they got it done: they selected some projects.*

The respondent was comparing the Alberta case to the UK, where significant funds were committed to CCS by the national government, but no suitable industry proposals were presented, and Norway, which has fully operational CCS projects (unlike Alberta), but the projects are located offshore, where there are fewer legal and regulatory complications, and public acceptance issues. For this individual, although Alberta has no fully operational projects, it is a world leader in a holistic sense because it has regulatory and financial technology supports in place. Another respondent echoed the sentiment that Alberta's leadership comes in the form of overall composition of the facilitative field for CCS, but with a different formulation:

> I27: *…from a geology perspective, ….we sit on top of the Western Canadian Sedimentary Basin, … what gives us all this beautiful oil and gas here in the west… those properties are the same ones that we generally look for in a storage container. So we've got world-class geology underneath our feet. [And] because of all the work we've done to explore for and produce resources within that geology, we've built up world-class expertise. We have the smartest geologists in the world in this province… and then the third …Most of our emissions come from large point sources at our industrial facilities. So there's far more*

amenable to capture than, say, for a jurisdiction whose emissions inventory looks different.

For I27, Alberta's leadership position is based on three conditions, one of which was an entirely natural endowment – geology. The other two conditions that made Alberta a CCS leader, in their view, were based previous investments and conditions from its oil and gas economy – geological and subsurface exploration expertise, and large point source emissions. Thus, the factors that helped make Alberta a world leader for CCS – the scientific, legal/regulatory and policy architectures of hydrocarbon exploitation – existed *prior* to, and independent of, any concerted effort to, the project of pursuing carbon capture and storage.

As such, two observations can be drawn out. First, Chapter 4 demonstrated that carbon capture, conceived as a coherent suite of technological components integrated for the purposes of reducing carbon dioxide emissions, is essentially a technological analogue of oil and gas technologies (EOR). It is now possible to see that the successful composition of CCS as a political technology is also based upon actors taking strategic advantage of *regulatory* analogues from oil and gas as well. One government of Alberta respondent articulated this notion in terms of a long-term realization of value from past investments in knowledge in the oil and gas spheres:

I14: *… when I think about value, I don't just think about the commercial value… it's the value from a policy perspective… a lot of the value from what we've invested over the years in this space is the fact that we know how to manage a reservoir to accommodate the injection of CO2. And we know what that's going to do to formations. We know how to monitor that. We know how to develop an MMV plan … How do you actually, when you think about it, how* do *you create a good? … It was pretty easy when we knew, you know, timber, oil. These are pretty easy goods to identify and articulate. Pore space? Calling that a good?! I mean like this is innovative! It was actually taking something we* knew *how to*

manage and applying it in a different space. It's a beautiful example of … innovation in the … in a whole regulatory sense. …

This respondent's comment accords with the argument that CCS is not only a technological translation, but also a regulatory translation.

A second observation is that Alberta's pursuit of a "world class" regulatory framework for CCS, and overall leadership in CCS, is strategic: by translating pre-existing oil and gas technological, regulatory and institutional "know-how" into a new climate change mitigation option, Alberta is pursuing a "race to the top" in a race in which it already has a head start.

My twin arguments – first, that not just technological expertise from oil and gas was translated into the new CCS carbon control strategy, but also pre-existing oil and gas regulatory expertise, and second, that Alberta's world leading role in CCS is a strategic translation from this 'head start' positioning, seem to be supported by the recollections of one provincial government respondent:

I7: *A lot of our issues, we looked at "What are other areas doing?" Some of them we didn't – like things like the overall regulatory process, it was kinda like, "Well, what was the point? We've got such experience and such a robust regulatory framework that we don't really need to look at what other people are doing." Same with when we were dealing with pipeline things. So, you know, we've got thousands of kilometres of pipelines in the province. Let's just look at what we have now and, and what we have for other industries in the province, and kinda go from there.*

As this respondent articulates, in many ways the Alberta government didn't have to perform the RFA as an external regulatory audit, since it already had significant endogenous know-how. Nonetheless, the Alberta government went to great lengths to "look at what other people are doing," and to include others in the process of reviewing its existing regulations relevant to CCS.

How does one account for this? In part, as I7 articulates, while Alberta possessed a strong, easily translatable overall regulatory system, there were CCS-specific gaps to be filled. The other reason, I argue, is that Alberta could invite "international scrutiny" of its regulatory system for CCS, confident that it was world-leading, because Alberta's oil and gas regulations are considered "world-leading." The province was also operating in a situation of "first mover advantage," since few jurisdictions in the world have enacted comprehensive CCS regulatory regimes. In this way, the RFA process itself can operate as a form of self-promotion, or mitigation against the negative claims about the rigour of its environmental performance discussed in Chapter 3.

It should be borne in mind that races are always selectively chosen by government and allied actors in a given jurisdiction, such that they 'compete' in races in which there are usually already front-runners.[114] Thus, as RFA Expert Panelist Don Thompson indicated, part of the means by which "Alberta is positioning itself as a key player" in carbon capture is because the RFA and other efforts "build on the decades of regulatory experience Alberta has in managing the oil and gas sector" (quoted in Government of Alberta 2011). One of the most prominent examples of Alberta's regulatory experience that contributed to Alberta's head start in CCS regulatory leadership is the province's experience with acid gas disposal, to which I now turn.

5.2.1 Using the 'Alberta Advantage': Directive 65 and Other Transferrable Analogues

I have now presented the argument that the actions of Alberta's CCS proponent community to advance this technology are strategic redeployments of existing technical and regulatory expertise in oil and gas production, translated towards the new goal of carbon control. While EOR was presented in Chapter 4 as an example of translated oil and gas technology and expertise, over

[114] For instance, the territorial government of Yukon is about as likely to aim to be a world-leading media technology hub, as the City of Tampa, Florida would be to strive to be a high-density city.

half a dozen respondents I interviewed also used acid gas disposal to describe how pre-existing technical and regulatory expertise were being applied to advance CCS in the province.

Acid-gas disposal (AGD) or acid gas injection is a practice by which "acid gas" – mostly hydrogen sulphide (H_2S) with CO_2 and minor traces of hydrocarbons – is injected into deep geological formations for permanent sequestration.[115] Acid-gas disposal has been used by oil and gas operators in Alberta and British Columbia for over twenty years, and, unlike EOR technology which was imported from Texas, the AGD technique was developed in Alberta in 1989 near Edmonton.[116]

According to one provincial government employee, CCS was less a new technology being developed in the province, than a continuation of an existing acid gas disposal practices. The only major difference between AGD and CCS, for them, is scale:

> Respondent: *... so in Alberta we have been disposing of CO_2 underground for like 40[117] years, as part of regulatory requirements for oil and gas.*
>
> EK: *In the form of acid-gas?*
>
> Respondent: *Yah, that's acid gas ... so H_2S, CO_2, other nasty things... OK, so we had been doing similar stuff for decades in Alberta. But when we're looking at CCS at such a large scale that we're looking at, you know, a million tons or more per ... [the] scale is a lot bigger.*

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[115] H_2S and CO_2 are naturally co-produced from some hydrocarbon pools known as "sour" pools, and need to be removed prior to bringing these hydrocarbons to market through a "sweetening" process (Bachu and Gunter, no date). Sour gas can be sweetened through surface desulphurization, but this technique is considered costly, and furthermore surface storage of produced sulphur presents a liability for well operators. In addition cost savings effective, acid gas disposal "reduces atmospheric emissions of noxious substances and alleviates the public concern resulting from sour gas production and flaring" (Bachu et al., no date).

[116] In the most recent figures I could find (for 2003), there were 48 AGD injection sites for 42 oil operations (35 in Alberta and 7 in British Columbia), accounting for 2.0 Mt H_2S and 2.5 Mt CO_2 and *already* injected into deep hydrocarbon reservoirs and saline aquifers in western Canada, at least six prior to "carbon capture and storage" becoming an official climate policy goal for the province.

[117] This timeline does not correspond with known timelines for AGD (Bachu et al. no date), but I took the comment to mean the technique has been practiced for many years.

An industry respondent echoed the notion that acid gas disposal is a technical analogue for CCS storage, and that the only appreciable difference between the two is scale. Furthermore, supporting my contention that CCS was strategically developed from antecedent regulatory analogues, the respondent also indicated that AGD is a pre-existing *regulatory* analogue for carbon storage:

> I23: *The ERCB has had regulations in place regarding the injection of acid gas, okay? And a CO_2 CCS project really isn't that much different than an acid gas injection project. The biggest difference is scale, okay? But the technology, the physics, you know, it's pretty much the same.*

In another interview, I asked a provincial employee who was involved on the Regulatory working group to what extent CCS is mapped onto pre-existing an oil and gas framework in terms of regulations and technical knowledge:

> I7: *... there are differences and similarities... on the ERCB side ... currently, ... the [Shell] Quest project is the only real CCS that's been approved. It was approved under existing directives. So Directive 65 has ... a chapter for acid gas disposal... So the ERCB put additional conditions on their approval that would not have got on your typical acid gas disposal approval. But I think they are mostly related to the scale...*[118]

This means, therefore, that Alberta's first CCS project, *as such*, was approved using existing acid-gas disposal regulations, rather than regulations devised specifically for carbon capture and storage.

[118] The ERCB (as of June 2013 known as the Alberta Energy Regulator) regulates Alberta's oil and gas activities through a series of Acts (legislation), regulations and rules, some of which outline the broad contours of the regulatory environment. In addition to these rules and regulations, many of the detailed requirements for operationalization are given through ERCB/AER "Directives." According the AER, "[d]irectives are documents that set out new or amended AER requirements or processes for implementation," which all oil and gas approval holders "are required to obey" (Alberta Energy Regulator 2014b). They can be considered the technical rules of oil and gas activity in the province. Directive 65, "Resources Applications for Oil and Gas Reservoirs," is the ERCB/AER that details the process by which operators may apply to the Alberta Energy Regulator (AER) for any approvals necessary implement and plan "to deplete a pool or portion of a pool" (Alberta Energy Regulator 2014a: 6), but also use a pool for disposal or storage of water, waste or gas/acid-gas. I7, therefore, was explaining to me that Shell's Quest CCS project received approval for the underground of their carbon dioxide through the chapter in Directive 65, which concerned the disposal of acid gas.

The Energy Resources Conservation Board also applied other regulations from oil and gas to regulate CCS. One respondent talked about how ERCB rules and directives pertaining for surface access, as well as CO_2 classification were also directly transferred towards the regulation of CCS:

> I7: *We looked at surface access - so that's getting access to landowner's property. And really we realized that there's already an existing process in place for that. So there wasn't really much needed to be done with that... How CO_2 is classified. And that was another one where we realized there's not much to do ... So, we just left it alone, basically.*

The same respondent also articulated that the existing regulatory process, at a general level, was already fairly well equipped to translate to CCS regulation:

> I7: *We looked at the regulatory process in general, ...basically taking that idea of the fact that this has basically been mapped onto the existing regulatory process, were there any gaps? Are there any things that we need to be doing within the regulatory process that are not being done? ... We realized, "No. There's things that need to be tweaked, but there's no big gaps." There's nothing missing ...*

The above paragraphs have shown how many components of oil and gas production - acid gas, surface access, gas classification – all showed a direct translation of an existing ERCB technical directive for oil and gas to carbon capture and storage. At a more general level, when there was not an existing technical directive in place, there was a recognition that the relevant body in question – be it the ERCB, Alberta Environment or Alberta Energy, had more than sufficient expertise to develop its own directive, without needing the input of the experts assembled through the RFA. Numerous instances of this confidence in regulatory capacity arose during my interviews, and I highlight one here.

One respondent described to me how although most of the RFA recommendations from the Regulatory Working Group were specific, in some cases, exact numerical prescriptions were left vague, both because the group did not have the expertise internally, and because they knew that the

body that would deal with the figures had enough internal expertise to determine an exact prescription at its own discretion. The respondent gave the example of how the Regulatory Working Group tried to determine conditions under which carbon capture and storage operators would have to notify adjacent subsurface rights holders. In oil and gas operations, ERCB regulations stipulate that other subsurface rights holders within 1.6 kilometres must be notified. The group was unsure whether the figure should be the same for a carbon storage operation, but they left the numerical value unspecified, to the discretion of the ERCB:

> I7: *… we knew that wasn't far enough because, like, for example, with Quest, they expected their CO_2 to move more than 1.6 kilometres from the well. So we knew it wasn't enough, but we certainly didn't have the technical expertise to say what it should be. So in that case, … our recommendation ended up being that ERCB should review these requirements and the ERCB the whole time was saying, "You shouldn't just assign us a number. We have the technical expertise internally." … And in general, I think especially when the ERCB was involved, if there were regulatory things that had a technical basis, we … basically left it to them to come up with an appropriate requirement.*

This confidence in the ability of the ERCB to successfully develop its own requirements for CCS based on its existing oil and gas expertise is based partially in the fact that the regulating body is regarded by actors in other jurisdictions as a world-leader in oil and gas regulation. One ERCB respondent told me:

> I15: *I mean, you're probably aware that the ERCB is always – quite commonly gets requests from different countries –government in different countries for information on how we regulate the oil and gas industry. We're seen as a world leader.*

Another interviewee, an RFA participant from the research sector, articulated that Alberta's CCS leadership claim is staked to its reputation as an oil and gas leader:

I26: *well, I mean, I think Alberta IS a leader. And in a sense always have been a leader and that's because of one of the strongest analogies, right? And that is acid gas disposal. Um... which has got a whole hell of a lot more danger to it than CO_2 storage, and we've been doing that for sort of 20 or 30 years... And lots of that knowledge has been directly translating into CCS. Both in terms of operators ... and also from a regulatory perspective. But the regulator – the ERCB – is comfortable with the idea of underground geological disposal of gases [...] I mean one of the ERCB's reactions all along has been "Well, this is just acid-gas disposal. There's nothing new about CCS. H2S is an acid-gas, CO_2 is an acid gas. We've already got a regulatory framework in our directives, which deals with this."*

These responses indicate that Alberta's strategy to strive for a 'world class' regulatory and policy environment for CCS is made possible by its comprehensive existing oil and gas regulatory regime. But the quest for world-leading position on CCS is not free, and as some respondents informed me, there are complications and costs to staking a claim to be a 'world leader,' as I now show.

5.2.2 World Class Benefits ... and Costs

Interviews with several policymakers revealed three dimensions of staking a claim at a world leadership position on CCS: 1) that CCS policymakers see the policy field as one of "takers and makers," 2) that being in a world-leading position on CCS comes with concentrated costs and diffuse benefits, but also that 3) the diffuse benefits come in the form of sending a image of Alberta to the world, a high priority for many Alberta actors given the triple climate crisis (discussed in Chapters 1 and 3). One respondent's answer touched on the question in terms of 'making' and 'taking' policy:

EK: *Is Canada slash Alberta ... are we leaders in carbon capture, or are we followers?*

I1: *We are leaders in most areas. So I mean, in policy geek speak … on some areas we are policy makers, and I would say we're clear leaders. And others areas we're policy takers, where we're happy to let others inform us. And sometimes that's strategic. Whether you want to be a policy maker versus a policy taker. Sometimes it's just because events overtake you, and others on that curve are ahead of us. I would say, though, that Canada is a leading jurisdiction. I don't ever like to say that we are sort of first in the race, but I think if you inventoried all the barriers facing carbon capture today, and if there were 30 of them, I think we're leading on half of them.*

The respondent is indicating that since CCS technology is itself a composition of multiple, interdependent technological, legal, political, organizational and economic factors, no one jurisdiction is likely to be a clear winner. However, from the preceding pages, it is clear that Alberta's leadership position is based partially on realizing value from areas of already existing leadership from the hydrocarbon sector. But in the same interview, the respondent indicated that Alberta Energy has strategically chosen to be a policy taker in the capture dimension of CCS:

I1: *…so capture-ready policy – we are a policy taker. It hasn't been deemed a high for Alberta. It's very high priority for other jurisdictions…, but it is an area that we will let others to the thinking, ask the questions, come up with clever ideas. And we'll likely take their policy and deploy it here.*

Another informant discussed some of the high costs of being a leader in carbon capture and storage. The high degree of international collaboration on CCS has meant that, for some Alberta government employees, international networking constitutes significant part of the workload. In asking another provincial government respondent what percentage of his work interactions with other bodies are Albertan or non-Albertan, he replied:

I27: *I would say that … my contacts externally outside of my team, I'm sure at least 50% are outside of …the Alberta stakeholder base… other states, other provinces, countries, companies or technology providers that are external to Alberta, and then sort of the big three international clubs for CCS, being the IEA, the Global CCS Institute, and the Carbon Sequestration Leadership Forum.*

This response suggests that, in no small part, the effort of incubating, regulating and building CCS policy and infrastructure in the province involves networking with bodies outside the jurisdiction, which takes significant amounts of time and labour. In particular, the "big three international clubs for CCS" (explored below) have played a crucial role in building an internationally coordinated network of CCS professionals. Yet I27's comments suggest membership in the club requires the expenditures of jurisdictional resources. I27 made further comments about the use of government resources (staff time), especially in the context of Alberta's explicit focus on knowledge-sharing:

I27: *…many jurisdictions around the world are keen to run an event, build a relationship, sign an MoU that creates pathways for knowledge transfer. And I get that. We live it too. We are disseminating a disgusting amount of knowledge, in a good way. But all of these knowledge loops, feedback loops, information sharing opportunities, consume resources that could otherwise be applied to actually addressing these barriers… here, if you will.*

EK: *Even though in the end, all that information sharing is in some ways about addressing those barriers?*

I27: *For policy takers it is. For policy makers, it's somewhat of a distraction. So if … one quarter of my team is in the business of disseminating knowledge, and I'm a policymaker – so I'm a net creator in giving you knowledge, that's brilliant for you as a policy taker. But*

you're consuming 1.5 million dollars of time to do this. That's the cost to me and the cost to Albertans…

EK: *So it's sorta concentrated costs, diffuse benefits?*

I27: *Exactly, very diffuse. […] but we do have some benefits. I mean, it's an opportunity to advocate. It's an opportunity to … continue to share facts with stakeholders. And we generally find most jurisdictions have … the wrong information about Alberta. Whether it's about …oil sands, about… our approach. So there's an opportunity there. But I would rather it be ten percent of my resources. And then keeping ninety percent focused on the problems… the issues, the research that needs to be done*.

The first portion of I27's comments suggest that, as a policymaker, this individual sees being in a world-leading position on CCS as coming with concentrated costs and diffuse benefits. While some discussions of contemporary dynamics of knowledge-sharing and the instantaneous nature of knowledge economies tend to foreground the seemingly frictionless, highly interconnected nature of networked knowledge-sharing platforms and "fast policy transfer" (Peck and Theodore 2010), this individual's reflections on their work reveals that "all of these knowledge loops, feedback loops, information sharing opportunities," in fact, do take large amounts of resources (time, labour, money, paper) to establish, maintain and expand.

And yet, the latter part of I27's comments indicate that these costs, however large, are providing returns to Alberta, in the form of "sharing facts" with the outside world, in order to (re)shape images about the province's resource extraction and environmental stewardship practices – they help reframe Alberta as a climate 'thought leader,' at least with respect to this technology. So, although CCS policy networking incurs costs for the Government of Alberta,

its CCS policy program acts as a political technology of policy 'signaling' (Spence 2002); participation in, and contribution to, CCS networks provides information to Alberta policymakers; but just as much, it sends (a particular kind of) information to the larger public sphere.

5.3 "You Missed What the Chinese are Doing on this Issue": RFA as Mutual, Mobile, Mutable Policy Learning

The above section served to illustrate that Alberta is able to draw on considerable pre-existing advantages to pursue these efforts. In many ways then, through its prior expertise in analogue technologies, Alberta has advantages with which to wager a world-leading position on CCS. Despite this, the Government of Alberta nonetheless valorized the participation of international actors. This section explores in more depth the reasons for, and implications of, the inclusion of individuals and organizations from outside of Alberta as a key component of the government's 'world-class' efforts in the RFA and beyond. The objective of this section is to examine the practices of "importing" and "exporting" of experts and expertise in the on-going development of carbon capture, in order to illuminate how transnational and international networking and policy-sharing practices are crucial dimensions of how carbon capture operates as a political technology.

As such, I analyze the RFA process as a specific instance of a broader process of the transnationalization of regulation and expertise. Transnationalization focuses on the uneven "archipelagos" (Peck 2012) of policy and technology innovation, by viewing place not as container, but as a key dynamic, in techno-political processes. The CCS Regulatory Framework Assessment offers an empirical example of "*how* transnational geopolitical practices are constituted in, and constitute, specific places" (Kuus 2011b: 423). While this section emphasizes these geographical

dimensions of expertise, Section 5.4 similarly focuses on the transactions and movements of knowledge, policy and knowledge/policy actors, but with an emphasis on movements across institutional lines rather than geographical locales. The two cuts are often interrelated, but are separated for the purposes of analysis.

The inclusion of the 'international' dimension in the RFA process came in two forms. The first was through the importation of information/knowledge through the RFA regulatory review, which consisted of a 'global scan' of best practices for CCS outside Alberta. The second form of international importation was the inclusion of international experts/expertise, invited as individuals and representatives of international organizations, into the process itself. Overall, there were nineteen international participants in the RFA, including six representatives from the CCS "clubs" – the Global CCS Institute, the International Energy Agency and the Carbon Sequestration Leadership Forum.[119] There were also a number of other non-Albertan RFA participants from elsewhere in Canada, primarily representing federal government bodies, and bodies of the provincial governments of Saskatchewan and British Columbia.

In practice, the importation of knowledge/information and the importation of experts/expertise was an integrated process. So, too, was the inward-looking assessment of regulations and practices with the outward-looking scan for best practices. I asked one provincial employee who was involved in the RFA process about this integrated process:

> EK: *I was wondering if those two are a really highly articulated operation, or if they're kind of two separate pieces.*
>
> I27: *They're not two separate pieces. This is one integrated effort. So we have … the four Working Groups …if you looked at the make-up of anyone one of these groups, there's*

[119] Note: in categorizing individuals as Alberta-based, Canada-based, or international, I considered industry actors as "domestic," indicating that while their operations might not be headquartered in Alberta, they were directly involved in CCS or carbon capture projects in Alberta. One exception was the three US-based representatives of BP Alternative Energy. BP has no active CCS projects in Alberta. Their participation, as indicated to me by interview I7, was based on an interest in having them share the BP experience with CCS in Africa and the USA.

gonna be Government of Alberta, Government of BC, Government of Canada, industry, academia, the IEA [International Energy Agency], where appropriate, and the Global Institute [Global CCS Institute]. That's the general make up of all of these teams. And if they look at any issue...it's both an internal and external look… concurrently… And then at the end it's … [the] same people doing these two pieces… it comes up as advice based on internal and external best practices.

The inclusion of international experts was highlighted in government press releases and websites. For example, in a 2011 press release announcing the Regulatory Framework Assessment, then Minister of Energy, Ron Liepert, stated, "We are very fortunate to have this dynamic group of people, who bring substantial international expertise in developing energy and environmental policy, guide this initiative" (Government of Alberta 2011). In this way, part of what constitutes Alberta's claim to 'world class' practices was the simple inclusion of international actors in the RFA process, regardless of the actual quality of the process and outcomes.

But the rationales for inclusion of outside expertise extends beyond optics. Besides enabling Alberta decision-makers to make a claim to world-class leadership on CCS, another central reason for the inclusion of outside experts was what I refer to as mutual policy learning. According to one Alberta Energy employee involved in the RFA process, one of the primary benefits of involving international actors was their ability to share their in-depth knowledge of CCS policy and regulation from other jurisdictions:

I7: *Basically at all levels we did have international people involved… And a big part of that was for this looking at what other jurisdictions are doing. We did that ourselves to the extent we could. But a lot of it's not easy to find. And part of the benefit of having those international people … they were very good at telling us well, this is what the UK's doing, or what Australia's doing, or other countries.*

EK: *It's sort of an embedded knowledge that you couldn't access otherwise?*

I7: *Exactly yah. And we might have been able to find it but it wasn't always easy to find. Especially the guys from IEA - that was their job - is monitoring what all the jurisdictions are doing… they were really good at providing that knowledge.*

This interviewee suggests that what expert participation in the RFA provided was timely, unofficial, context-rich knowledge – "hidden transcripts" (Scott 1990) of regulation – that would have been difficult to glean remotely through official documents, or two-hour workshops at international conferences.

One of the RFA participants I interviewed was an IEA representative whose full-time position is primarily to coordinate a network of that puts together regulators who work on CCS regulatory issues. The inclusion of representatives from the International Energy Agency (IEA) in particular was strategic, since a large portion of the mandate of these organizations is "authoritative knowledge-sharing" (Interviewee I9). This sharing was "dialogic" (Peck and Theodore 2012: 2): Alberta actors learn experiences and best practices from other jurisdictions, but also 'international' actors add Alberta's actions to their reconnaissance duties. I asked the IEA interviewee a two-part question: what did their organizations bring to the RFA, and what did the RFA process contribute to their organizations?

EK: Wh*at did the IEA bring to the RFA process?*

IEA Representative: *I think we … brought a lot of expertise in having looked at this problem a lot … [we] brought in great references to legislation and developments elsewhere in the world – very good knowledge of what happening maybe in Australia or in the UK, or the European Union, more broadly… that was the main thing that we brought to …into the process.*

And in response to what participation in the RFA brought to the IEA, the same respondent stated:

IEA Representative: *And in terms of getting out, I think it's the same thing. We really had …a front row seat to how the sausage is made. And that was really interesting. And … the issues that came up were very valuable because …there are issues that …other countries are only beginning to grab hold of. And so Alberta, in some sense, was …a bit of a first-mover… Alberta went from policy to actual kind of regulation through law to regulation very quickly… Alberta worked very fast moving in this way, and had a very open process that we could be invited to.*

Through the RFA process the Alberta community receives otherwise hard to find access to 'good practices' from elsewhere, and IEA, in turn, produces new 'best practices' from Alberta's exercise, then able to transmit these back to the IEA and to other member countries.

I also asked the Global Carbon Capture and Storage Institute (GCCSI representative) why non-Alberta government actors would devote so many hours to a process initiated by Alberta:

GCCSI representative: *Well, I mean, from the Institute's perspective it's – we feel it's part of our mandate to understand these things… what happens in Area A is going to impact in Area B. So … I think we were … quite happy volunteering, knowing that we would be able to spread the knowledge further than Alberta. […] I think the Institute has a role in getting [the RFA] past Alberta, if you will, to say to other jurisdictions "Hey, look what Alberta has done, here's a pretty good model for others to follow."*

Just like the IEA representative, this GCCSI representative saw the RFA process as one that would enable better knowledge dissemination for her organization and its member countries. I also asked her the same two-part question I asked of the IEA representative:

EK: *What did the GCCSI bring to the RFA process, and then, what did the RFA process bring to GCCSI?*

I9: *We brought expertise to the table … in terms of debating and drafting what the recommendations look like, what the supporting text looked like. We spend a lot of time on that […] What the process bring to us, is once the regs are drafted, the final reg is …a pretty good model CCS regulatory framework that… you can apply … probably not quite universally, but probably might wind up being seventy percent of what's in there could be used almost anywhere.*

Just as the GCCSI representative seems to suggest regulatory frameworks can be taken, copied and applied to other jurisdictional contexts, another participant also spoke about the RFA as a 'borrowing' process, explaining that Alberta had already "borrowed" its list of priorities from the IEA:

I3: *And the issues we had were actually borrowed from the International Energy Agency's model regulation framework. So that was a document that they put out in 2008 or 2009. And so we certainly didn't start from scratch. We looked what the IEA put together … we borrowed from the IEA – what their issues were…*

Knowledge-sharing, borrowing, traveling the world to get a "front row seat to how the sausage is made," and sharing context rich information unavailable in books or conference papers in order to advance CCS capacity overall – these actions and strategies suggest something far from the siloed, competitive process in which jurisdictions vie for policy and regulatory first-place standing, as might by the notion of place competition. Policy scholars have for sometime realized that policy learning and transfer are now "continuous, if not endemic, processes" in policymaking processes the world over (Peck 2011; see also Dolowitz and Marsh, 2000).

As we saw with respect to work on policy mobility and 'mutation' in Chapter 2, many of the same scholars who have observed the competitive dynamics with respect to economic competition and place-making have also observed that pursuits for pre-eminence are being formulated and

reformulated in networks that connect jurisdictions, individuals, and sectors to establish cooperative relations on both policy and technology innovation.

As I9's comment – "seventy percent of what's in there could be used almost anywhere " – suggests, policymaking processes like the Regulatory Framework Assessment are at once mutual (involving benefits for both the hosting government and the experts who share), mobile (applicable to many other jurisdictions), and mutable (their comment suggests the remaining 30% are subject to the contingencies of place and context-specificity). Conceived as mutual, mutable and mobile, policy processes and practices of regulatory auditing and international review are revealed as "relational constructions" that "through their very movement … (re)make connections between these sites, evolving in form and effect as they go" (Peck and Theodore 2012: 4). Yet, in the view of Dezalay and Garth, who have investigated the relationship between global influences and state transformations, Alberta's strategy to bring in outside expertise for its regulatory assessment would constitute an "international strategy." This refers to "the ways that national actors seek to use foreign capital, such as resources, degrees, contacts, legitimacy, and expertise," yet always with the end goal "to build their power at home" (2002: 7). The strategy of some of the international "clubs" for CCS can ultimately be viewed the same way.

Learning and borrowing also happened for industry participants through for rule learning, and preference agenda setting. Industry also contributed as actors who could share hands-on experience in CO2-EOR. First, in terms of rule learning, a commonplace belief statement uttered by government and hydrocarbon industry alike in Alberta is the notion that industry 'likes' regulatory certainty. One non-industry RFA representative reflected on how the RFA, and previous measures like the Specified Gas Emitters Regulation, acted as a strong signal, messaging to industry that the Government of Alberta would have CCS projects operating in a regulatory environment with as much regulatory certainty as possible:

I18: *Alberta is clearly, from a policy perspective taken a pretty strong leadership position, in terms of being very clear, …that this is being backed up with actual plans to regulate emissions and those …sorts of things – I think that really got the companies to the table. Not to mention the demonstration projects, and I think you had some of the strongest participation were from companies that …were … awarded money from the demonstration fund.*

Second, industry was motivated to participate for what I call preference agenda setting: to, as much as possible, influence the RFA agenda, process and outcomes to match their preferences. Shell, for instance had a representative sit on all four working groups, and one Shell representative sat on the Steering Committee:

I9: *If you look at the companies that were engaged in that – and I think of Shell in particular, they had a vested interest in making sure that the regulations were as close to what they wanted as possible. Now, because the group was so large, they didn't get their own way all the time.*

Finally, industry participation in the RFA occurred in the form of the GoA making direct invitations to companies that have been involved in CCS or EOR operations in the past, in order to glean from their experience:

Industry representative: *Again, due to our technical expertise, and our experiences with [EOR projects], the government did ask us to participate in the RFA… we do sit on a couple of the Working Groups … to provide our technical expertise and our knowledge gained, if you want to call it that.*

Rule learning, preference agenda setting, and sharing experience are often a tightly integrated bundle of moments when 'working together' with government. Immediately after, the industry representative continued:

> Industry representative: *We also were consulted with Alberta Energy... around the generation of the* CCS Act*, okay? So yes, absolutely – again, industry and policymakers have to work together. Because if you can generate policy that industry can't ... live up to... then what good is the policy? But if industry isn't regulated by policy, what good is industry?*

In showing how sharing experience (the company's past work on EOR got the government interested how their experience could translated to CCS regulation), preference agenda setting (consulting government on a piece of legislation), and rule learning (therefore having a first-hand knowledge of upcoming rules) are integrated, I23's words provide further evidence of how contemporary policy and legal regimes are increasingly created through and with the 'privatization of regulation' (Buthe and Mättli 2011), creating the new norm of governance through, but beyond, the state.

5.3.1 Membership Pays: The Role of the CCS Clubs in Alberta's CCS Effort

This subsection describes the "the big three international clubs for CCS" (Interviewee I27, above) - the International Energy Agency, the Global CCS Institute, and the Carbon Sequestration Leadership Forum, and their role in Alberta's RFA,[120] as well as to suggest their significance for the international CCS effort.

The first international "club" for CCS is the Carbon Sequestration Leadership Forum (CSLF).

[120] Across all components of the RFA process, there were six representatives from the "clubs," as follows: one individual from the IEA Greenhouse Gas R&D Programme (Working Group), two persons from the International Energy Agency (IEA) (Working Groups), and three representatives of the Global CCS Institute (one on the Steering Committee, two on Working Groups), and no representatives from the Carbon Sequestration Leadership Forum.

Founded in 2003, the Forum acts as a platform for international cooperation to facilitate carbon capture and storage techniques. The organization is a national ministerial-level organization, which includes 22 member countries and the European Commission. As a forum, it has less staff dedicated to data collection and support provision than the GCCSI or the IEA. CSLF membership is open to nations that are users of producers of hydrocarbons and that have committed to CCS research and development. Although there was no official CSLF representative involved the RFA, one of the members of the RFA Expert Panel I interviewed represents Canada on the CSLF, and one respondent interviewed indicated they were the Canadian delegate to the CSLF around 2006/7 while working for the federal government. This indicates that, although there are three international clubs for CCS, it is nonetheless a relatively small, tight-knit community of individuals who populate, and circulate through, these clubs.

The second international club for CCS is the International Energy Agency (IEA). The IEA was established within the framework of the Organisation for Economic Co-operation and Development (OECD) in 1974, in the wake of the 1973 OPEC "oil crisis" as a sort of counterpart of to OPEC (Mitchell 2011). The IEA now acts as, arguably, the most pre-eminent source of global energy information, forecasting through its "Energy Outlooks" and "Technology Roadmaps" publications:

> IEA Representative: *...in time we've had a role in collecting energy statistics – [it] is a big part of the organization- [it] collects data for every country in the world.*

As such, it is a key authority on, and centre of knowledge production, on energy, as well as on CCS (discussed at length in the following chapter):

> IEA representative: *So CCS is a special position at the IEA, where we have a surprisingly large, really, number of people working on it. I think we have ... 6 full-time analysts who are working on CCS, which is probably the largest number of analysts working on any single technology at the IEA.*

This is remarkable given the relatively minimal impact CCS technology has had on GHG mitigation compared to, for example, solar and wind technologies. When I remarked on this prominent position of CCS in the organization's priorities, my respondent informed me that such a position was afforded by a $10 million (AUD) grant from Australian PM Kevin Rudd, who also granted to the seed funding for the Global CCS Institute (see below).

The IEA helps to facilitate policy learning and regulatory transfer between jurisdictions with respect to CCS. Furthermore, the organization uses information provided in the network to produce its own annual reporting. The IEA representative described the link between network facilitation (increased capacity) and knowledge production:

> IEA Representative: *In terms of working with other organizations, I mean the IEA, … a big part of any international organization … is, …very few international organizations actually do work [laughs] … I'm gonna qualify that: I mean in the sense that they're hubs kind of to connect people, for the most part. … and so we can get people, organizations in contact… We can kind of try to make that... connection.*
>
> EK: *But is it fair to say that you certainly do much more, in terms of – my idea is that it is not only a hub, but also a synthesizer of information and data?*
>
> IEA Representative: *Yes, it absolutely is… that's part of the reason why … We're really supposed to be doing analysis and that's kind of our …core [unclear word] if you will. But to do that – to do good analysis at the international level, we're always trying – having to talk to people, to get the right kind of inputs.*

He described that the fifty (out of two-hundred EIA staff) that do scenario analysis of energy systems, spend a long time having to talk to people from various regions of the world to find out what's happening at the regional scale:

IEA representative: *... I can't go to Indonesia and understand that biomass supply chain and how that's going to influence global energy system, so we spend a lot of time talking to people to try and figure out OK, "What – tell me the salient facts, point me to papers and reports that I can integrate into our work." And so that's part of the reason they do so much connecting.*

What this all means is that "a huge part" the "real analysis" performed by the IEA, is producing authoritative knowledge by connecting with, and synthesizing existing information from, a vast network of *other* organizations and actors.

The third club, the Global CCS Institute (GCCSI), is an Australia-based member organization that was started with $315 million in seed funding from the Australian government in 2009, under Prime Minister Kevin Rudd.[121] The mission of the GCCSI is to accelerate the deployment of carbon capture and storage, which is accomplished through "sharing expertise," capacity building and support services. Large-scale demonstration was the initial key focus of the organization, but two important outputs of the GCCSI are its yearly "Global Status of CCS" reports, and its interactive online "Status of CCS Project Database." GCCSI members include governments, transnational corporations, smaller companies, research bodies and NGOs. As the newest of the three CCS clubs, I asked the GCCSI representative what the unique role of the GCCSI has, compared to CSLF and EIA:

GCCSI Representative: *Well you have to remember that the CSLF is a volunteer organization that is - only has governments as members... Now there was some outreach to stakeholders, but... it [CSLF] was – it wasn't bringing stakeholders in as they should be. And the industry, ... like the private sector, found that it [GCCSI] was ... a more useful forum... So we've [GCCSI] has evolved over the years, and we've sort of come down to three main things that we look at now. One of what we call [1] authoritative knowledge-*

[121] Funding is structured such that in 2014 seed funding ran out and Institute activities are now funded through dues from members.

sharing. And then there's [2] fact-based advocacy, and [3] strengthening the capacity for CCS implementation.

This brief look at the three international CCS "clubs" shows that they serve a number of key roles in the effort to advance CCS, neatly described by the GCCSI interviewee. Firstly, corresponding to the notion of "strengthening the capacity for CCS implementation," all the clubs act as networking nodes – across borders, between governments, and between sectors. The IEA respondent above showed how networking not only serves to advance CCS in its own right – by recruiting and connecting actors into the network in order to facilitate policy, technology and project advancement, but also serves as the means to accomplish "authoritative knowledge-sharing" as the GCCSI interviewee put it. But the clubs do not just share knowledge – they also produce it, like the yearly IEA *Outlooks*, and the GCCSI *Status Reports*, and their scores of press releases, downloadable slide presentations and other documentary outputs. Third, armed with authoritative knowledge (as well as ample, state-backed financing and institutional support), these three clubs are in a position to champion the advancement of CCS through "facts-based advocacy." As such, knowledge-sharing, advocacy and capacity building are deeply interconnected, as demonstrated by one of the CCS club respondent's statement:

Respondent: *Well, in Alberta … there isn't actually a lot of need for advocacy … but elsewhere, through the UN process, we were very vocal about the CDM*[122] *issue, and one of the reasons that it is now in the CDM is because Mexico – We were very strong in supporting CCS, and Mexicans through their presidency got it on the table and it got refined in Durban. So that's one area where we've been pretty strong advocates. And we write policy papers to hopefully influence policymakers. We also participate in something*

[122] Clean Development Mechanism (CDM), is a process under the Kyoto Protocol by which an Annex B Party (a country with an emission-reduction commitment) may "implement an emission-reduction project in developing countries" in order to earn saleable certified emission reduction credits that count towards Kyoto targets in the Annex B country (United Nations Framework Convention on Climate Change 2014).

called the Clean Energy Ministerial … and we support that process with documents, reviews, ideas and so forth.

This respondent's statement shows that the capacity for CCS implementation is strengthened through the actions of international clubs. Regarded as an authoritative source of knowledge, the CCS clubs are widely believed to have "the facts." And once these facts are written into, say, policy papers directed to the Mexican presidency, the facts become points of advocacy. Using the instrument of the nation-state state, and its powers to table items in the UNFCC process, the advocated facts furnished by the clubs (that CCS should be a valid instrument of the CDM) become an accepted part of the Kyoto Protocol. This, in turn, opens up the doors to new venues of institutional and monetary support – increased capacity – for CCS implementation. As such, we can view knowledge-sharing, advocacy and capacity building as distinct but articulated political technologies that when conducted by authoritative sources. They serve to legitimize and realize CCS as a climate change mitigation option.

Publically available documents from the clubs' websites would seem to indicate all three clubs regularly coordinate in their policy steering and governmental advisory efforts. They also coordinate on key targets for the G8, the OECD, the countries they represent, and as a result, the world at large. For instance:

I9: *We came up with a series of recommendations to the G8 which were submitted to their meeting in Japan, which was I think in July 2008 … one of which anybody remembers, which was to build 20 demonstration plants by 2020.*

There is a further way in which the CCS clubs are involved in advocacy. All of them are products, directly or indirectly, of two larger "clubs," the G8 and the OECD. As indicated above, the IEA is a direct sub-entity of the OECD. Meanwhile the CSLF was created within the context of the G8 meetings. As Campanella describes, the CSLF was formed after then US president George Bush Jr.

declined to ratify the Kyoto Protocol, and instead lobbied the G8 for the establishment of an international organization supporting CCS as a viable climate change strategy. "The CSLF, " writes Campanella, "has since operated as a central force in promoting the legitimacy of CCS, and preparing recommendations for the G8" (2011: 42). The Global CCS Institute is also associated, although more indirectly, with the G8.

5.3.2 Homegrown Vanguards: Exporting Domestic CCS Expertise

Two more aspects of the mobilities of CCS expertise and policy are analytically relevant. This subsection articulates some of the actions of Albertan and Canadian 'homegrown vanguards' of CCS. I do this in order to highlight that Alberta's position within the larger international CCS effort is not dependent just on the importing of expert from other jurisdictions, but has also been built from instances where Canadian and Albertan expertise, capital and know-how were 'exported' to other jurisdictions and international forums.

Chapter 4 showed early examples of knowledge-sharing and technology transfer activities occurring between Albertam/Canadian and international actors in pursuit of EOR and CO2-EOR technology. As another illustrative example, in the early 1990s, Natural Resources Canada (NRCan), a member of CORDNET, participated in an international research consortium to run test of oceanic carbon dioxide disposal off the coast of Hawaii (Campanella 2011: 20). While ocean disposal proved publically unacceptable, the participation of NRCan in overseas research in another country reflects not only the significant role of the state in CCS activities, but also reveals that national research agendas are not restricted to the territorial confines of the nation.

According to Bill Reynen, a NRCan employee who had been active in CO2-EOR for over a decade, "[m]any of the CCS leaders at the time [in the late 1990s] were Canadian: Bill Gunter, Stefan Bachu, Malcolm Wilson, Kelly Thambimuthu" (Reynen 2007). He suggested that although

CCS technology was "largely unknown in senior circles" of the federal bureaucracies at that time, many government and parastatal scientists were conducting vanguard research both domestically and abroad (*ibid*.).

Today, Alberta CCS scientists and researchers might not enjoy quite the same spotlight they did in the mid-1990s:

Researcher: *Now its ... really crowded. Today it['s] very hard to pull ahead.*

EK: *In the CCS world?*

Researcher: *Yah, because there are so many people.*

On the other hand, I found that Alberta CCS scientists still play an important role on this CCS world stage. Perhaps the most high profile example is Dr. Stefan Bachu's co-authoring of the 2005 IPCC Special Report on CCS (discussed in the next chapter), for which he and other authors won a Nobel Peace Prize.[123] A more recent example is the role of Albertan and Canadian actors in the development of the world's first ISO CCS standard, a process being is being co-chaired by China and Canada, with an Alberta-based individual filling Canada's seat.

Much as international experts were invited to Alberta to participate in its regulatory review process, similarly, several Alberta CCS actors I interviewed were involved in review processes and expert collaboration for projects in other countries, be it the Sleipner CCS project in Norway (I32, I5 interview), a project review for the Otway CCS project in Australia (I32), or helping with a peer review of Chevron's Gorgon CCS project in Australia (I36), or others. I also found, not surprisingly, that publishing that has contributed to the international reputation of Alberta CCS scientists. For instance, the associate editor of the *International Journal of Greenhouse Gas Control* is an Alberta scientist.

[123] The role this IPCC Special Report played in legitimating carbon capture and storage is discussed in Chapter 6.

The most prominent example of 'vanguard' Alberta/Canadian expertise, and Canadian leadership on carbon dioxide storage, is the IEA-GHG Weyburn-Midale CO2 Monitoring and Storage Project. Located at an EOR plant in Midale, Saskatchewan, scientists from around the world come to run experiments at the facility, and data is shared through the IEA-GHG programme (Legg, McDonald and Wilson 2002:1057).[124]

In other example, after 'importing' expertise from international expert for the RFA, some Alberta actors are now being asked to 'export' this knowledge to other jurisdictions:

> EK: *So I was wondering if, other than the RFA, if you have an… illustrative example of how Alberta Energy has worked with others…*
>
> I7: *Sure... I don't know if you are familiar at all the IOGCC. It's the Inter-state Oil and Gas Compact Commission. … It's a US organization… of states that have oil and gas operations. So, they have this CCS taskforce … [my co-worker] and I are both sitting on this phase of the Taskforce. And it's looking at how to deal with and manage liability for CCS... They've invited us just mainly because of the experience we've had over the last two years in going down the same road of figuring out how we'll deal with liability… And it's basically kind of like a smaller version of the RFA, for them. Except now being the ones running it, we're one of the experts that they've brought to the table.*

5.3.3 Connection and Context: The Networked Petro-Developmental State

So far in this section I have discussed the significance of the inclusion of extra-local actors in Alberta's Regulatory Framework Assessment, with the goal of understanding the degree to

[124] Although the oil well and two billion-dollar commercial EOR operation is owned by Cenovus (a Canadian integrated oil company, formerly Encana, formerly PanCanadian), International Energy Agency's GHG (IEA-GHG) Programme (discussed in the following subsection) operates a carbon capture monitoring, measuring and verification (MMV) programme, which is managed by the Saskatchewan-based Petroleum Technology Research Centre (PTRC) (Petroleum Technology Research Centre 2014). The CO_2 for the project comes from a gasification plant in Beulah, North Dakota, and is transported by pipeline to Midale. A much smaller, though similar project was the coalbed methane research conducted in Alberta's Fenn-Big Valley, which featured participation from European countries and US Department of Energy (Legg et al. 2002:1057).

which the circulation (whether imported or exported) of knowledge, policy, expertise, and embodied experts are constitutive moments in the advancement of CCS in any one jurisdiction. Pairing empirical data from interviews with critical approaches to the movements of policies and people demonstrates how "connection matters" (Peck 2011) when considering the regulatory and policy decisions of any given jurisdiction. Peck contends that attention to *connection* in policy needs to be paired with the importance of *context*. He suggests that the sites of policy exchange and action "are more than empty spaces across which borrowing and learning take place; they are dynamically remade through the traffic in policy norms and practices" (2011: 3), and dynamically contribute to the creation of new forms of governance. Indeed, I have shown that while Alberta was the recipient of significant outside attention and information, the province's significant pre-existing translatable expertise meant that the Alberta context also helped (re)make CCS for the rest of the world.

The lens of geographical critical policy studies allows one to see that the *international* CCS community carrying out the work of policy and knowledge production for the continued development of CCS is not 'out there' beyond Alberta, but also shaped by, and constituted through local actors, institutions and events (Campanella 2011). In this section I have demonstrated that, whether through the prominent role of CORDNET in the first decade of international CCS conferences (Chapter 4), the role of an Albertan geotechnical expert in a Nobel Prize winning IPCC report, or the hopes of a GCCSI representative that a seat at Alberta's RFA table will enable his organization to export 70% of regulatory recommendations "almost anywhere," the so-called international scale is in every instance localizable, instantiated through the practices and discourses of governments, organization and individuals in particular places. The 'international' dynamics of CCS are instantiated not just through international peer reviewed publications and conferences, but also through, for instance, the localized experiments that constitute the subject of such conference papers, or the once-nationally specific CCS regulations that become 'international best-practice' through the import and export of experts and expertise.

As such, Alberta is a portion of a larger network, constituted through mutually constitutive processes of "(relational) networking and (territorial) rooting" (Rocheleau and Roth 2007) that can be traced empirically. The Alberta case shows, "the possibilities that the governance of global environmental issues might emanate from the 'bottom up'" (Bulkeley 2005: 879), originating in local contexts. They become 'internationalized' through relatively transparent and straightforward institutional and social pathways like peer-reviewed journals, but also through more ad-hoc processes like the transfer of unwritten, embodied experience of bureaucrats sharing their experiences on the RFA with peers across borders. By attending to the ways in which policies, practices and knowledge emanate from the "local" scale, one might re-conceive of the international scale less as a discrete geographical scale, and as more as a process of a critical mass of trans-local exchanges.

It should be noted that the majority of knowledge production and exchanges on CCS occurring internationally are between only ten countries. These can be divided into two sets of jurisdictions: industrially advanced, high fossil fuel consuming, high fossil fuel producing nations (Bridge and Le Billion 2010) like the US (oil, gas, coal), Canada (oil, gas, coal), Australia (coal), UK (offshore oil and gas), Germany (coal), and Norway (oil and gas); and a group of industrially advanced, high-consuming nations – Japan, the Netherlands, France, and Sweden. These ten countries consistently rank in the top in terms of government research and development budgets for CO_2 capture and storage and for attendance at the bi-annual GHGT Conferences (Stephens and Liu 2012: 141, 135). As such, carbon capture and storage is a climate change mitigation strategy largely of wealthy industrially advanced nations producing large amounts of per capita greenhouse gas emissions. I propose this small group of nations, in particular the fossil fuel producing set, be called networked petro-developmental states. These countries advance their carbon economies and carbon control management strategies through cooperative, highly networked knowledge-sharing conduits, doing so within a framework inter-state competition for economic pre-eminence. In these

countries, the state assumes a variable, but sometimes high level of intervention to either maintain economic pre-eminence, or to direct a fossil fuel-based national development agenda (particularly in the case of Canada, Australia, Norway and the US).

But it should also be noted that within these countries, the development of carbon capture is highly uneven within national spaces (for example, the concentration of CCS activities - physical projects, knowledge-production and regulatory/policy activity – in Alberta, Saskatchewan and Ontario.) One could say that the socio-institutional arrangements supporting CCS are like "institutional archipelagos" (Bigo 2008, Kuus 2009): geographically uneven, but punctuated and discrete sites of CCS knowledge, expertise, experts and power, highly connected to each other across regional and national borders through a series of networks and relations, more or less formalized. With this analytical construction, it is possible to view the movements of discourses, policies, people and technologies as leapfrogging from archipelago to archipelago.

Specific locales in these archipelagos are produced by, and themselves produce, "institutional thickness" (Amin and Thrift 1994) around communities of interest within concentrated geographical areas. The dense web of connections between the Universities of Alberta and Calgary, the Alberta Research Council, the Alberta Energy Research Institute, the Alberta government and hydrocarbon industries based in Calgary, have created a twin node of CCS institutional thickness in the major Alberta cities of Edmonton and Calgary. Edinburgh is another site of CCS institutional thickness, also closely associated with hydrocarbon institutional thickness, with similar dense inter-linkages between the University of Edinburgh, the UK and Scottish governments and the operators of nearby offshore gas fields. Given the high volume of policy and knowledge flows between these archipelagos, it becomes somewhat difficult to maintain the picture suggested by the existing literature on the social dynamics of CCS – one in which a single community at the international hierarchically contains a series of discrete national sub-communities, with distinct international and national scale activities, "a nested hierarchy of

geographical arenas … like so many Russian dolls'' (Brenner et al. 2003: 1). As such, national-scale framings, employing an implicit state-centric framing, risk not fully taking into account the impact and geography of non-state actors shaping the social geography energy and environmental governance (Emel et al. 2010: 70).

Yet the notion of the networked petro-developmental state, as well as the observation of empirical cases up close, is a reminder that although contemporary governance has shifted, it is still thoroughly anchored to the state. At the end of the day, it was the provincial Government of Alberta that invited these actors to the RFA process, for its own benefit. Thus, the creation and reproduction of the Alberta CCS network involves processes of (re)scaling of political, regulatory and knowledge-production processes, by actors that "operate simultaneously across scales" (Bulkeley 2005: 879) (like a former Natural Resources Canada employee now working for an international CCS club, or a University of Alberta CCS researcher involved in the creation of the International Standards Organization CCS standard). Paying attention to the connections *between* sectors, locations, organizations and scales, is crucial in order to apprehend the rescaling of environmental governance occurring in Alberta and beyond, one in which actors, communities and jurisdictions dynamically craft the project of CCS as carbon control "from practices and politics taking place at a multitude of sites and scales of governance" (Bulkeley 2005: 879).

The following section will focus on the organizational connections across sectors (government, academic, etc.), which is made possible by high levels of porosity *between* sectors, which is in part constituted through the individuals who work across such sectors.

5.4 Traveling Technocrats, Trading Hats and Revolving Doors: Re-bounding Regulatory and Knowledge-Production Processes

This section will show that 'importing' and 'exporting' international CCS expertise is one dimension of a more general aspect of CCS: that the spaces and connections 'in between' constitute some of the most productive sites for advancing the CCS fix. In this section, I will argue that the image of the 'triple helix' (Ektowitz 2003, Stephens and Liu 2012) in which industry, government and academia are treated as discrete categories of actors, presumed to act towards distinct sets of interests, does not capture actually existing dynamics in the Alberta case. Taking an actor-centred focus, this section advances the argument that the Regulatory Framework Assessment was as much a social process as it was a process consisting strictly of data collection, and the sorting and arrangement of information. By investigating the micro-sociological worlds of the experts and actors that are working to institutionalize CCS, this section demonstrates the need to refine our understanding of the social life of expertise in order to more fully account for the ways in which Alberta's CCS fix is made possible.

The previous section showed that both international and domestic experts were drawn into Alberta's CCS Regulatory Framework Assessment at the institutional and organizational level. In this section, I show that mobility and mutation occur at the micro-social level, too: in some instances manifest as the mobility of actors between sectors (revolving doors and consultants/contractors), and in others as the mutation between roles and expertise (trading hats). In their work on the role of lawyers and economists in the post-World War II internationalization of American state forms and economies, Dezalay and Garth advocate for a "biographical approach" as a research strategy "to understand who these individuals are and where they come from in order to see the relationship between what they say and their own strategic position" (2002: 9). While I did not deploy an explicitly biographical approach as my central research strategy, it did form a

component of my line of inquiry during interviews: in each of my interviews I asked my respondents what education and experience had led them to their current position. For Dezalay and Garth this approach enables the researcher to overcome "the artificial segmentation" that sectoral frameworks (such as the triple helix) produce, enabling us to better see, in their words, the "relationships and influences that cut across existing categories and institutions" (*ibid.)*.

In sub-section 5.4.1, I show that individual-level motivations influence actors' participation. These motives can be considered "hidden transcripts" of the development of CCS, in that these reasons are expressed "'offstage,' beyond direct observation" (Scott 1990: 4), and beyond the openly stated rationale for the RFA as expressed to the public. The latter sub-sections (5.4.2 – 5.4.5) will show that the effort to advance CCS occurs less between sectors than at the fuzzy margins, where sectoral divisions and interests are often less clear. Part of what makes sectoral divisions fuzzy are individual employees, who by 'trading hats' and circulating through 'revolving doors' make it at times difficult to determine whose interests they are working on behalf of.

5.4.1 Traveling Technocrats and Hidden Transcripts: Performing Objectivity and Boosting Careers

In Chapter 2, I examined expertise and the role it plays in governance functions, arguing that it is both relational and performative. In this sense, for example, when Alberta Energy enlisted Dr. Edward Rubin of Carnegie Mellon University to advise on the RFA Expert Panel, they were not just interested in receiving the information this individual might have; just as valuable was his status as a world-renowned CCS expert and his "strong interest and record of accomplishment in developing energy and environmental policy" (Carnegie Mellon University 2011). To say that Dr. Rubin sat, literally, on the Expert Panel, was of particular and unique importance to the goals of the RFA. His status as an expert was signaled by the Alberta government to the public in their

announcement of his participation on the Expert Panel by listing off his accomplishments and credentials under his name,[125] demonstrating his status as a purveyor of expertise afforded by his thorough embeddedness in institutions of credibility and status (like US federal advisory committees, and the IPCC). Inviting Dr. Rubin to the Alberta RFA process, therefore, makes a relay between his social relations to these institutions and the RFA, lending the latter validity. The previous section showed that "context matters," (Peck 2011) insofar the places in which policy and knowledge circulate both shape, and are shaped by, particular places and geographical scales. Yet, context also matters in terms of the sociological origin and exchange points of the expert claims that underpin many policies (see Chapter 2).

In Section 5.4 I presented Minister Liepert's sentiment that Alberta was "very fortunate" to be able to bring in "substantial international expertise" for the RFA, since it brought both prestige and, accordingly, a stake to which Alberta could better claim that its CCS regulatory regime would be world-class. Interviews revealed a further reason why the provincial government explicitly sought out international experts for the Regulatory Framework Assessment. I asked one provincial government respondent about the decision to sometimes bring in outside expertise:

> EK: *Would it be fair to say that …there is a body of in-house expertise, … but as is seen fit, outside expertise can be brought in?*
>
> I18: *Yah, and I think the main reason for the outside expertise, you know, there may be expectation from … outside that we do go to them… It helps validate our work.*

Another provincial government respondent echoed that the inclusion of international actors was about validation, and a way of preventing a critical response to the RFA process as being self-serving, and self-reinforcing:

[125] This included his 200-plus technical publications, service of US advisory committees, and service to committees of various US National Academies, as well as his track record of CCS-related accomplishments, including Nobel Prize for the co-authorship of the 2005 IPCC Assessment on CCS.

I27: *We wanted people not to say: "This was just an Alberta effort being promoted by Alberta experts. So of course you land in Alberta-centric responses." We need that - international validation of our approach is really overdue.*

For I27, one of the manners in which 'outside' expertise performs, as such, is to validate the RFA process itself, by lending 'objectivity,' and to legitimate Alberta's CCS efforts. She commented further:

I27: *Right. So the best in the world are right here [pointing to the 'Expert Panel' box they've drawn]. [...] I think the difference is the objectivity this group can bring. They have not been at the table to any of this debate, deliberation, context. They come in clean. They are CCS experts, but they haven't been swayed by any of my companies, my investors, my environmental NGOs, my academia... They're just objective. They just get to hear your clever advice that's based on a thousand hours of talking with many stakeholders, and say: "Ah, you missed this. You missed this issue. You missed China, or whatever."*

It is interesting to note that I27 argues that the internationally selected Expert Panel "come in clean" (provide objectivity) because they have not been entrained in any of the "debate, deliberation, context" of Alberta's petro-political machine. But this is not an accurate depiction of the Export Panel: two of the five members of the international expert panel, Don Thompson and Stefan Bachu, are from Alberta, and each came from a longstanding career related directly to the fossil energy sector that might make observers skeptical of the GoA's objectivity.[126] The inclusion of Thompson and Bachu on the 'international' Expert Panel could be read as case of 'stacking' the Panel with known strong supporters of Alberta's approach to CCS. Or another logic might be at play: both individuals, especially Bachu, could be considered world leaders in CCS, and their inclusion on

[126] Thompson was an energy executive, a lead on the ACCSDC, and considered a 'champion' of CCS in the province. Bachu is a renowned geoscientist, and perhaps the name most associated with CO2 storage in the province.

the Expert Panel helps send the signal that Alberta can claim world leading status because it hosts such world leaders in carbon capture.

It should also be noted that not only 'outside' *qua* extra-jurisdictional actors helped provide validation and objectivity. The inclusion of Alberta-based academics and NGOs who were outside government proper seem to have brought the same benefits. One Alberta research sector respondent shared:

> I26: *... from the government's perspective, I was probably seen as being reasonably balanced and reasonably competent on the issues...I think it helped them not to have just industry and government people ... And they really only had one ENGO member from Pembina on the Steering Committee, so I think I was sort of valuable to them from those perspectives, putting it utterly and completely cynically.*

Indeed, even though the RFA "only had one ENGO" representative – the Pembina Institute, several provincial employees I interviewed stressed their inclusion in the process:

> I3: *But I want to highlight for you probably our key ... one of our key stakeholders is the Pembina Institute. [...] we realized if it's just government, industry and academic, just the perception of the whole RFA is, like, "Oh, you're all in bed together," and, you know, it's not going to be that big of deal. But having Pembina on board – they made everything so much better because they – they DID provide that balanced view.*

As Mosse suggests, successful governance depends on reputation and legitimacy, and these can be considered "scarce resources for governments, donors, state development agencies ... operating in competitive environments" (2004: 45). As a result, any sort of signaling of due process, objectivity and progress in terms of environmental efforts become "points of political leverage" (Li 1999: 297) for the Alberta government and the fossil polity against claims of environmental irresponsibility, regulatory capture, etc.

The notion that outside expert operates outside the context and debate of Alberta issues, suggested by I27, neglects that fact that, through their invitation into the RFA process, such actors are now *part of* the Alberta context. One respondent's perspective on why experts are being imported and exported to and from various jurisdictions around the world explicitly put it in such relational terms:

> EK: *... because Alberta is doing this RFA right now, and they're sort of bringing in experts from all over the world, ... At the same you also see [Alberta] experts and CCS know-how folks that are also going to other places in the world... So I don't know if you have any thoughts on ... why were you asked to go to Australia, and not in-house people from Australia?*
>
> I32: *Well, yah. I think they just look for certain ... expertise. And then a lot of it is relationships. Right? I mean, ... even some of the stuff on the RFA was relationship driven. People knew certain people. And at certain levels I think there was some early relationships built through the process of the IPCC reporting, and the report on the geological storage of CO_2.*

It is noteworthy that the invitation of some experts on the RFA committees and groups were the result of pre-existing personal relationships.

An additional 'hidden transcript' rationale for the participation of experts in the RFA, therefore, is personal interest, which is a mixture of more or less self-serving motivations, like personal interest in the topic, or contribution to one's career path. One aspect of personal interest was candidly articulated by a government respondent:[127]

[127] Another example of the role of individual career aspirations and prestige in the functioning of expert advice bodies was an anecdote told to me by one scientist I interviewed. This individual was an expert in carbon storage related geology, and was invited to participate on a high-level US expert panel on hydraulic fracturing technology. The individual suggested that once a person is invited to a number of advisory boards, one "gets a reputation" and invited to ever more panels, even when the issues do not fall directly in the scope of one's expertise (fracking, in their case).

I7: *I'm sure part of it too is, just, you know, stroking their egos. You know, when you go and talk to someone and say, "You're an expert on this. We'd like you to come and help us because we need your expertise." People like to hear that kind of thing, and then they're like "Yah, sure."*

Another respondent articulated personal interest in terms of their own personal investment in carbon capture and storage:

EK: *Why did so many stakeholders get together around the RFA process?*

I18: *… I mean, I did my PhD in this area so, you know, I have investment in it, personally. And… I guess it's not a blind investment… So … I personally was participating in it … Yes, it was part of my job, I probably didn't HAVE to be in it, but I was in it because I thought it was a really interesting process. To me a lot of it was driven by… "This is really interesting to be involved"… and it was a lot of learnings that I can take from that to [my work]… it genuinely was an interesting process for me…*

Another RFA participant, a scientist, described more generally why they participated in advancing carbon capture and storage, describing it as a deliberate career choice:

Researcher: *… I would say early 2000 … That is my luck was that I saw it as opportunity … Early on, I made a deliberate decision to move in to this field which for me was basically applying [my preview knowledge to a new purpose] … So the basic knowledge is the same. I had to acquire a few more things because carbon dioxide [acts differently], but otherwise its still [the same principles]…*

Thus, for some actors, the translations of oil and gas 'know-how' to CCS (explored in Chapter 4) acted as conduits or channels through which individuals in Alberta's fossil fuel-based economy

could navigate and compose their own personal careers. Recollections from many of my interviewees revealed that the capacity to influence RFA process outcomes were often as much about personal social competencies as any sort of strict technical, or subject matter, know-how. This supports Bourdieu's claim that, ""technical" competence depends fundamentally on social competence and on the corresponding sense of being entitled and required by status to exercise this specific capacity, and therefore to possess it" (Bourdieu 1984: 409; in Kuus 2011). One respondent for example, described how he and one other member,

> I26: *were probably the most vocal on the Steering Committee, in terms of reviewing and commenting on the materials.*

He related that he was able to push for certain recommendations on the Steering Committee not based just on his specific disciplinary expertise but also because of specific prior experiences in multi-stakeholder processes at the national and international level:

> EK: *I appreciate that distinction in terms of … having expertise or experience in terms of process … Is that a key capacity arguably to have?*
>
> I26: *I think so, because you have to make the effort to understand other people, right? And … I think it also gives you the confidence to ask the questions. Because, … if you're not sort of comfortable within your own discipline, and working with other disciplines, [the process] can shut you down pretty quickly.*

The discussion thus far has helped to illustrate the notion that the Alberta multi-stakeholder processes like the Regulatory Framework are as much social processes as knowledge transfer and knowledge production processes. A key constituent of these social processes are individuals whose work in advancing CCS brings them across institutional, provincial or national borders. Whether homegrown vanguards, or imported experts, many of the individuals that people

I spoke with are examples of what Larner and Laurie (2010) have called "traveling technocrats," individuals working at the technical-bureaucratic interface in globalizing process of policy transfer, development and knowledge-production (see Chapter 2). In describing traveling technocrats as "embodied actors who knowingly create careers for themselves through and against broader political-economic processes and national imaginaries" (Larner and Laurie 2010: 219; see also Dezalay and Garth 2000), they draw attention to three aspects of expertise examined so far: it is an embodied practice, the personal career choices of individuals is an analytically relevant component of policy processes, and *macro*-scale processes like globalization, technology breakthroughs, and the global circulation of policy, are least in part the sum total of micro-level transactions of such actors.

First of all, as Larner and Laurie suggest, these persons are e*mbodied* actors: if Peck and Theodore and other policy geographer have drawn out the important observation that *policies* are both mutable and mobile, and Kuus has suggested that expertise is an embodied performance, then Larner and Laurie's figuration essentially combines the two. They show that that one of the vectors of the mobility (and mutation) of policy is the physical movement of traveling technocrats (whether traveling from Paris to Calgary on behalf of the IEA, or from the halls of the Alberta Research Council to a carbon storage test site in China).

A second analytically significant aspect of these traveling experts hearkens back to Latour's notions of interest articulated in Chapter 3. Although these actors are key components of the work to build and maintain the technical, regulatory and political architecture for CCS (their *interessement* in CCS is a necessary component of its trajectory), their personal commitment to carbon capture and storage, *per se*, might be much more ambivalent than their efforts would suggest. As Larner and Laurie put it, "whilst global… processes involve the mobilisation of national imaginaries and the export of national models, the engineers themselves do not necessarily buy into these national success stories, and may indeed be ambivalent about the marketing of their own

expertise" (2010: 224). For example, one respondent described the widening pool of expertise in CCS, and how the increase in had to do with following money that follows changes in institutional spending priorities:

> I26: *And I think now that it's a much, much, much wider pool of expertise … In most cases though, you'd find that it's … a much wider* apparent *pool of expertise… But most of it is textbook smart. Very few people have had to battle it through a real project. So if you went looking, especially in the literature and you grab all the names, and you said: "OK, how many of you have been involved in a project that went from site characterization through to simulation, install stuff, inject the CO_2, analyze it, make sense of it?" Very few… But now CCS was such a hot topic …that it involved, if you like, the same kind of expertise, you know, injection, movement of fluid, porous media, seismic. Well everyone does seismic. They do it for oil. You say, "Well, OK. Do some CO_2 stuff." Right? So they do some analysis – they push the paper and whatever, right? But what you find is that in the end, … there's a really a small pocket of people who would have the kind of depth of experience where they've battled though this stuff.*

The respondent indicates that following the money to CCS has gotten many researchers into carbon capture and storage, himself included. In his description, furthermore, he reveals that the ability to do so is dependent on prior expertise in oil and gas ("injection, movement of fluid, porous media, seismic") and the ability to translate this expertise to a new domain of inquiry.

The movement of research interests based on funding availability relates to the third important aspect of the traveling technocrat. For Larner and Laurie, this figure, "points to the centrality of multiple and shifting forms of expertise in the reconfiguring of political-economic institutions, ideas and techniques" (2010: 224; Dezalay and Garth 2000: 8, Theodore and Peck 2011). As seen in Chapter 4, the development of carbon capture and storage saw a coherent

technological object develop incrementally over the course of the last twenty years, involving as Larner and Laurie suggest, the reconfiguring of institutions, ideas, techniques, as well as funding priorities and policy frameworks. When left to answer who counts as a CCS expert, one finds that with the exception, perhaps, of a recent wave of new 'highly qualified professionals' trained in the later half of the first decade of the 2000s (I8, I26, I35), many CCS experts have become so by shifting their prior, related expertise in related fields. One also finds that, as a composite technology (capture, transportation, storage/sequestration, MMV), with an expanding architecture being constructed around it, CCS expertise is broad-ranging, and nothing if not very much still in-the-making. Literal travel (across geographical space), for many in the CCS community, therefore, seems inextricably entangled with figurative travel across subject areas, ideas and institutional association.

5.4.2 Hybrids, Not Helixes: Institutions and Actors

Among the findings in their studies of the movements, motivations and implications of so-called traveling technocrats, Larner and Laurie also found that the travels of experts were both geographical and sectoral. In noting that, "[e]xperts are increasingly moving between private, public and third sector organisations" (Larner and Laurie 2010: 219), they draw attention to fact that actors' inter-sectoral movements reshape the institutions and organizations which they travel through. The inter-sectoral movement of actors emerged as a strong theme in the course of my fieldwork, and this section I discuss these movements and their implications. I will show that in the Alberta case, this inter-sectoral movement was facilitated by that fact that the boundaries between sectors are themselves often fuzzy. These movements matter because they represent some of the micro-social constituents that help produce regulatory capture at the structural level (see Chapter 3).

At the outset of the chapter, I introduced Ektowicz's 'triple helix' model, which was used by Stephens and Liu to classify the international CCS community they observed. Ektowicz (2003) uses the triple helix metaphor to argue that technological innovation happens through the coordinated efforts of three helixes: government, industry and research communities. Yet, I argue, such a conception of coordination among actors in technological innovation processes fails to capture a key dimension of the manner in which CCS "innovation" is occurring, namely hybridity. This hybridity appears in several forms: community hybridity, hybrid organizations, actor hybridity, and close links between fossil fuel interests and the research community in Alberta.

The first, in fact, has already been explored in Chapter 4 and earlier in this chapter. I have shown that the Alberta CCS community is itself a hybrid consisting of members of its antecedent hydrocarbon communities plus some new actors. One government respondent articulated how the ability to work well with other parties during the RFA was a result of pre-existing strong relationships:

> I27: *I mean, yes. The Alberta government has a long-standing history of building great relationships … with my universities and my Alberta-based RD&D community… [on] oil and gas research. So… we're leveraging …and applying what is already an existing and strong relationship … to this new technology… And there are many, many examples of … us doing that.*

The second manifestation of hybridity occurs with respect to organizations and institutions. For instance, many of the organizations and institutions examined in Chapter 4 are hybrid institutions: Alberta Innovates Technology Futures and Alberta Innovates – Energy and Environment Solutions operate simultaneously as government, industry and research organizations. These organizations are arms-length entities of the provincial government, yet their core operations involve scientific research, their mandates are centred around technology

commercialization, and AITF, in particular, operates with a corporate model. An interview with one government respondent reveals that the distance between the Alberta Innovates corporations and government proper is relative and variable. At once, the Corporations are framed as "include[d]" in the provincial Ministry, yet their *activities* are not:

> EK: *what has your ministry done recently in regards to CCS that is NOT the RFA process…*
>
> Ministry Representative: *If you include… the Ministry includes the Alberta Innovates Corporations, … obviously then the answer is yes, because AITF does a lot of research in this area and AI-EES funds work in this area. THEY do work in that area. The department [Alberta Innovation and Advanced Education] doesn't do work in this area, okay?*

This begs the question: when hybrid entities, such as the Alberta Innovates corporations do work, who precisely do they work on behalf of, and to what degree one might consider their actions towards CCS as state activities, or something more complex?

The multi-stakeholder bodies introduced in Chapter 4, like the Alberta Carbon Capture and Storage Development Council (ACCSCDC) can also be regarded as hybrid institutions. They were ephemeral, but were funded by government, and acted as advisories and consultants to government for the purpose of institutionalizing CCS as a state developmental priority. They were constituted by public, private and academic representatives, yet were themselves not public-private partnerships, nor QUANGOs (Bulkeley 2005: 881). It is troubling that these multi-stakeholder bodies produced reports as official Government of Alberta publications, yet are clearly populated by the interests of constituent organizations.

The above examples serve to demonstrate that many organizations associated with CCS activity in Alberta perform multiple roles and functions, and their classification as either 'government' or 'industry' or 'research' bodies obscures more than it reveals. In particular, it obscures what sorts of legitimacy, authority and accountability ought to be afforded to these

institutions, and what sort of interests they represent. Since organizations like AITF or the ACCSDC operate neither as purely government, industry or research bodies, but instead operate at the intersection between them, it is difficult to assess what sorts of knowledge sets, narratives, and policy assumptions they enable to transfer between constituent helixes. These organizations, in short, operate like recombinant DNA (rDNA) molecules to create new sequences of knowledge-production, governance, management and business interests that would not otherwise occur in their absence.

A third manifestation of the hybridity in Alberta's CCS network are the many individuals who work across sectors. These are traveling technocrats of a different sort that operate, as Stephan and Paterson describe, as "agents both deeply embedded in complex networks, institutions and discourses, …who are messy hybrids rather than ones that can be neatly categorized as representing particular interests" (2012: 554). Again, the triple helix concept leaves no analytical space for such CCS actors.[128] Actor hybridity in the Alberta CCS community manifests in a few different forms: contractors and consultants, who may move between sectors rapidly, or work simultaneously across sectors; hat-traders, those actors whose professions 'mutate' over time, often from engineering to policy; and revolving door hybridity, where actors move between sectors in the same line of work.

During my fieldwork I encountered in many instances actors working in one sector also worked as contractors or consultants for another sector. At least half a dozen of the individuals I interviewed fell into this category, such as a semi-retired ENGO staff who did repeat contract work for a Government of Alberta Ministry; an engineer who worked as self-incorporated contractor who had done work for Alberta Energy, and also worked as a sessional instructor at the university; and a government parastatal scientist contracted by Alberta Environment, who had also done consulting

[128] Although see Ektowitz's update of the concept, which "provides an explicit framework for the systemic interaction between Triple Helix actors that was lacking heretofore" (Stanford Triple Helix Research Group 2013), to include consideration of ""single-sphere" and "multi-sphere" (hybrid) institutions."

work for ICO2N, Natural Resources Canada, another provincial government, and a law firm. The consequences of the increasing use of consultants to undertake the research and policy formulation activities of government are worth considering. As one government respondent articulated:

> EK: *Is the contracted voice just seen as more neutral, or do they bring a perspective that in-house experts just couldn't possibly?*
>
> I18: *I'm not sure ...I would think that in a way... If you are a contractor with a professional designation, you probably hold more weight perception-wise than you would if you were a government employee with a professional designation... and that's just a whole perception thing.*

Whether contracted consultants lend more or less objectivity is an open question: unlike the governments that hired them, consultants do not need to seek re-election, and face minimal public scrutiny.

The prevalence of contractors and consultants hired to work on CCS issues is one aspect of a larger phenomenon I observed in the CCS community, which I refer to as 'hat trading:' those actors whose professions 'mutate' either over time, or from one work assignment to the next. In their research on traveling technocrats, Larner and Laurie similarly note that, "as different forms of expertise begin to travel so too do they mutate; technocrats may become politicians, scientists may become development experts, academics may become activists, engineers may set up NGOs, and so on" (2010: 219). They specifically note the movement of workers from engineering practice to managerial practice to policy work, something I also observed with several of the persons I interviewed. For example, one of my respondents started their career at the Alberta Research Council in engineering research before crossing over to the public sector in positions that became increasingly policy focused over time. Starting off as a government engineer, at one point, the

respondent was "pushed into a management role," but found he liked it. I then asked him how a managerial role led him to eventually work exclusively on policy:

> EK: *So how does that happen? Is a manager position kind of a bridge between engineering and policy?*
>
> I3: *Once you get into a management role … in government, as you go up the authority ladder, you just can't do engineering any more, right? That's when you become more or an advisor and a leader on policy type issues, and then you can have a staff of engineers to do the science for you to help develop your robust policy.*
>
> EK: *… Why do policy roles ends up going with leadership roles?*
>
> I3: *Because I think policy* has *to bring in not just science, right? … When you look at the three pillars of sustainability – environment economic and social – you can have engineers helping you with mainly …the environment stuff. But social, you'll need economists, right? And economic – of course, economists, right. But you also need some of the more general type thinkers … So I see policy as, like, the umbrella with a lot of these types of knowledge underneath… It also has something to do with experience and maturity- as people age they tend to have a better grasp of a more holistic view – which is a policy type of knowledge. It would be hard for me to go back to just air emissions engineering now, because can't help but have holistic picture.*

From my respondent's perspective, the relatively common hat trading from engineering to policymaking has to do with increasing authority in the government sector, and a holistic perspective afforded by experience. Nonetheless, it is desirable to ask what the implications of 'hat trading' actors are for the analysis of CCS in Alberta, in particular. I submit that, no matter what the level of holism garnered from experience, one should attend to the unacknowledged particulars –

particular ways of describing, framing, and valuing the world – that shuttle their way in from engineering perspectives into managerial and policymaking roles.

For instance, it is noteworthy that although the respondent was trying to describe the types of expertise required for the holistic sustainability lens, he mentioned only two professions: that engineers could cover environmental issues, and economists could cover the rest.

One segment of another interview I conducted helps elucidate another dimension of the question of holism:

> EK: *When you were sitting in on conference calls… did you think about the different hats you were wearing – like did your involvement change once you switched form one organization to another…?*
>
> I18: *No, I mean, the only objective that we have in our work, kind of, is to make sure that CCS is done safely and effectively where governments and society wants it done. I mean that's kind of our … I think that was the same between [my current position] and [my previous, concurrent position]. I mean that was fairly consistent. I mean as an academic, I could kind of do what I wanted [laughs], but I'd say that those goals were consistent, in that sense... I think I approached it the same way, at least I certainly didn't think about the hat I was wearing.*

For this respondent, also an engineer-turned-policymaker, the goal of safe, effective and publically accepted CCS constituted the core objective of their work. This represented a universal aspect that superseded any distinct and/or differential commitments this individual had to make depending on the hat they were wearing. I submit that what both I3 and I18 have in common is a working worldview which presupposes a *particular* arrangement of the forces of science and technology, of the economy, and of government, but which does not include space for the contradictions and tensions that arise from the possibility that there might be alternative

trajectories for these forces. Timothy Mitchell, in his historical analysis of the role of Western experts in the modernization of Egypt from British colonialism to the present, noted a similar worldview amongst 19th century English colonial administrators, when he noted that, "[m]odern government, like modern science, the European believed, was based upon principles true in every country. Its strength lay in its universalism" (2002: 54). Yet as Mitchell also contends, universalisms tend to hide their "origins in particular histories" (55), such that in the case of many of the actors involved in advancing CCS in Alberta, the specific arrangements of knowledge, capital and governance underpinning the envisioned role of CCS within society are taken for granted, rather than themselves being subject to scrutiny.

The third type of actor hybridity in Alberta's CCS community arose from the "revolving door" phenomenon, which refers to the movement of personnel between roles as regulators or legislators, and the industries subject to such regulation and legislation, or into the role of lobbyists who work for industry interests (LaPira and Thomas III 2014). Here I use the term in a loose sense to connote the movement of individuals between the government, industry, research and NGO sectors. In the course of my interviews, I asked most respondents about their own personal career trajectories in order to understand how they came to play a role as experts in CCS. It became apparent that many had career paths that led them to different sectors over time. For example, in one instance I was asking an interviewee about whether their role of Alberta Environment with respect to CCS had it changed over time, and they responded:

> I6: *It probably has. I should mention that I've only been at the government …for two years. I've always been in the private sector before this. So … I'm a petroleum engineer. And I worked for a natural gas pipeline company. And I also worked with service rigs … Then I went back to school.*

In another example, an individual went through the revolving door as a result of the RFA process itself. One government interviewee relayed the situation:

I3: *And actually … he was a Pembina representative on… one of our Working Groups… So that's actually how we* knew *about him, and then he applied for a job here and … then we poached him.*

A final example shows us why actor's circulations through inter-sectoral revolving doors matters. In one interview, I was trying to elucidate from the interviewee what specific form of expertise they brought to the Regulatory Framework Assessment:

EK: i*n terms of specific expertise that you brought, how would you describe that expertise? Is it a general -*

I9: - *Well, I sort of came through the policy shops in Natural Resources, so … it was, you know, what makes sense. I mean it's not rocket science, but it's a question of being practical. And what will work, and what won't work.*

This interviewee's response to my query about expertise seems to suggest that his particular expertise was common sense (knowing what is practical and what will work) that applies to both government work, work in a wide variety of multi-stakeholder processes, as well as work in an international research and policy institution. He was suggesting that there existed a uniform common sense that could be universally applied in whatever context or sector he found himself in. That there would be a sense common to both government and industry and research and NGO communities is remarkable. This trope of pragmatism, called a 'common sense,' represents the production of a unified, universal lens – the 'principles true in every country'- that the hat traders brought to their work. Parallels can be drawn not only to Merton's 'bureaucratic intellectual' (1945), but also to Kuus' work on European Union bureaucracy. She notes a similar production of

uniformity with respect to political pragmatism, suggesting that the manner in which this uniformity is produced should be subject to our investigation:

> "Even if we accept the position that the main product of Brussels is uniformity, we must not dismiss it. The task is the opposite: to pick apart how such uniformity is produced on a daily basis in the offices, conference rooms, and cafeterias of the EU Quarter, and with what effects. The bureaucratic routines and technologies should not be taken at face value, but neither should they be discounted" (Kuus 2011b: 431).

I contend that the mobility and mutability of actors, and the fuzzy boundaries between sectors in many instances operate in tandem. Figuratively speaking, one could say sector porosity is, in many instances, caused by the 'punctures' created by the movements of actors across these sectors. This contention is supported by Larner and Laurie, who similarly showed that, "traveling engineers are not simply embedded within globalising …processes, but also that these processes are shaped through their movements" (2010: 223). Likewise, for Dezalay and Garth the biographical approach "allows researchers to see how institutions and professions are made and gain legitimacy out of various kinds of professional and social capital" (2010: 10), suggesting that the rise of the institutionalization of CCS, whether through the Alberta Carbon Capture and Storage Development Council, or the Regulatory Framework Assessment, is inextricably tied into the professional networks, career aspirations, and personal connections of actors in both Alberta's 'old' carbon networks (oil and gas, coal), and in the 'new' carbon network of CCS and carbon control.

Despite the kinds of novelty and differentiation that might be suggested from the metaphors of mobility and mutation, I have indicated that the movement of actors across sectors and roles might actually work to produce homogenization: the production of a particular "common sense" about how CCS, and energy policy and pollution abatement more generally, ought to unfold. One might argue that the greater the production of uniformity of operating sensibilities across sectors, the more the interests of both the individual actors and their respective institutions become

unclear. The production of a common sense about CCS through narratives and techno-scientific storylines is explored in depth in the chapter 6. But first, the final sub-section takes a closer look at the "unique" (Bolger and Isaacs 2003), and particularly close relationship between scientific research knowledge-and the fossil fuel industry in Alberta, which points to one of the ways in which a particular 'common sense' of the role of CCS in Alberta is produced.

The final subset of institutional hybridity revealed by the development of CCS in Alberta is the fuzzy boundary between a fossil fuel agenda (enacted through both industry, as well as some state actors) and academia, which is relevant given the overlap of oil and gas and CCS expertise and institutions discussed in this and the previous chapter.

In her examination of the influence of hydrocarbon industries in government and public spheres Alberta, Carter (2010) highlighted the links between Alberta academic institutions and hydrocarbon industries. Examining the corporate funding to educational institutions at the university and college level, Carter reports that "[s]ince the 1970s, approximately $3 billion has been invested by industry and government to support research on augmenting fossil fuel development in the province" (2010: 18-19). At a general level, the impact of the direct endowment of universities from corporate sponsors might be ambiguous. Academic researchers are under no explicit obligation to pursue research contributing to a hydrocarbon extraction agenda:

> I35: *Well our researchers… as far as they're concerned, they have their own motivations… Most of them are academic scientists. Most of them are not trying to generating IP to make a fortune. And in fact if they were, they wouldn't be doing research in this field. What they want to do is move the state of science forward and publish the results. And so if there's technology leakage into China they're not so worried about it.*

Yet there are ways in which more or less explicit incentives to do so are being increasingly integrated into the structure of research universities like the University of Alberta, the University of Calgary, and others. The fossil fuel industry investments in the Alberta university system that Carter describes are not channeled into the institution as a whole, but directed towards particular programs and faculties such as engineering and energy policy, where industry might expect 'returns' in terms of the production of knowledge from these programs that supports industry objectives and interests.[129] In 2003, the University of Calgary founded Institute for Sustainable Energy, Environment and Economy (ISEEE), an new institution with a central goal to "increase conventional and unconventional oil recovery rates" (Carter 2010: 19). ISEEE worked with Alberta Energy Research Institute (AERI) (who funded ISEEE studies) (University of Calgary 2008), as well as Alberta Oil Sands Technology and Research Authority (AOSTRA), and Alberta's fossil fuel industry.[130] Carter notes the significant presence of industry members in ISEEE's in the board of directors. ISEEE was a prominent intellectual centre of carbon capture and storage research in the province during the institutionalization third phase of carbon capture.

A key mediator of the link between research institutions and industry within the province is the Alberta Science and Research Authority (ASRA). The composition of ASRA, and the role it plays in directing research money into Alberta's government, quasi-governmental and university systems was candidly described by Bolger and Isaacs, in the same 2003 piece (explored in Chapter 4), where

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[129] For instance, in 2004, Imperial Oil Limited's committed $10 million to the University of Alberta for its "Imperial Oil Centre for Oil Sands Innovation," making it at the time the "largest investment ever made by Imperial in a university, and the largest single corporate cash commitment ever received by the university's Faculty of Engineering" (Carter 2010: 19). By that time the University had already built the new, branded "Markin/Canadian Natural Resources Limited Natural Resources Engineering Facility" building. As of 2011, Canadian Natural Resource Limited was Canada's largest oil company, known for its operations in the Alberta oil sands.

[130] ISEEE was the subject of a controversy in early 2013 when Dr. David Keith, a former director of an interdisciplinary group within the institution (who was also one of the five members of the 2008 EcoENERGY Task Force on CCS (EETF)), called ISEE a "failure" – specifically for being "poorly managed and not operating as independently from the private sector as it should" (Canadian Broadcasting Corporation 2013b). Keith contended that the Institute "removed" a member of its academic staff at the request of pipeline giant Enbridge (Canadian Broadcasting Corporation 2013b), and argued that this and other actions, "fundamentally misconceives the university's role" (Canadian Broadcasting Corporation 2013a). While Liberal opposition members at the time called for an investigation, I am unable to find any evidence of follow up on the part of the University of Calgary or the Alberta provincial government.

they advocated strongly to government-industry-research sector collaboration for carbon dioxide capture technologies:

> "The role that public–private cooperation has played in the history of the energy industry in Alberta to date is, to our knowledge, unique. The Government of Alberta relies on the Alberta Science and Research Authority (ASRA) in making decisions on research investment. When we explain to colleagues elsewhere in the world that ASRA's board is made up mostly of private-sector members, we're usually met with some very surprised looks. It seems logical to us, however, that industry leaders would be heavily involved in making the strategic decisions on where money for research and technology development should be invested, since we're counting on those industry leaders to apply the resulting technology to benefit all of us" (Bolger and Isaacs 2003: 12).

It is, indeed, surprising for many not familiar with the hydrocarbon regulatory capture present in Alberta that the central authority in the province charged with the direction of science and research is heavily peopled with (fossil fuel) industry actors. Even with such familiarity, it is surprising that these two figures so readily identify the interests of 'industry leaders' squarely the best good of science, and the highest benefit in the public interest. And given Bolder and Isaac's heavy involvement in bringing about the carbon capture and storage agenda in the province, we can see that the close fossil fuel-academia link extends into the world of CCS as well. For example, one of my interviewees recalled how a research centre at the University of Alberta's School of Business was asked to create a business case for CCS for the Alberta Carbon Capture and Storage Development Council:

> I16: *And then almost at the same time, [the Government of] Alberta was running their Carbon Capture and Storage Development Council, and [the University of Alberta School of Business] Dean at the time, Mike Percy was on the Development Council. And so he*

asked the research centre [Centre for Applied Business Research in Energy and the Environment] to complete some economic analysis on potential policy options to implement CCS. So that turned into part of the business side of the CCS Development Council's report.

If upper echelons of the provincial fossil fuel social network are composed of highly interconnected sectors, institutions and actors, it makes sense that the same would be the case for the CCS network that arose from it, if not more so, given its novelty and smaller size. One respondent's recollections of the work they'd done over the years, first in oil and gas applications, and then in CCS applications, spoke (evocatively) to the small size of the network:

I32: *… So we've done a bunch of kind of stuff like that. Yep.*

EK: *We being… Yourself?*

I32: *Yah, just myself. Yah, I just say "We", but there's a lot of times, it's the same criminals, all. Right? Same criminals, I mean. It's, you know, the Quest thing was with [Paul Armstrong].*[131] *But [Paul Armstrong] and I worked together for [Project Y]. And then [he] and I worked together on [Project Z] and all those things – so same kind of criminals, right?*

And another respondent made an equivalent comment about the small size of the network when I asked them about an early CO_2-EOR project:

I5: *… So the government said, you know, basically told [the company] that they had to let us tack on the monitoring program and so … again, it was the same old crowd.*

This section has shown that the spaces and connections 'in between' constitute some of the most productive sites for advancing the CCS fix. By taking an actor-centred focus, this section

[131] Name changed.

showed that the Regulatory Framework Assessment was as much a social process as it is a process consisting strictly of data collection, and the sorting and arrangement of information. I also showed that the effort to advance CCS occurs less between sectors than at the fuzzy margins where sectoral divisions and interests are often less clear. As such, I suggest that the porous boundaries between sectors, roles and disciplines are a constitutive element of the development of CCS as a regime of carbon management, and may be necessary for it to function as a technological fix in light of Alberta's carbon management problems. This, therefore, demonstrates the need for 'rebounding' and 'rescaling' analytical categories in order to grasp the pursuit of CCS in Alberta as a process that simultaneously reinforces state-making endeavors, whilst operating beyond-the-state. Whether the analytical cut is places or people, Alberta's experience with the Regulatory Framework Assessment seems to exemplify Berndt and Boeckler's observations about contemporary mobilities in general, that "global movements of capital, goods, people and ideas always involve an ambivalent double play of de-bordering (overflowing) and bordering (framing) processes" (2009: 546).

5.4.3 Governance Beyond and Through the State

Extending from the previous chapter that traced the formation of carbon capture as a translation of previous CO_2-EOR technology, this chapter has focused on the further acts of composition necessary to constitute, institutionalize and promote carbon capture and storage as a coherent technological, discursive, and policy object. This chapter paid close attention to the local-international connections composed to advance carbon capture in Alberta and to the mobilities and mutations of knowledge and actors between jurisdictions and sectors. So why do the close relationships between local CCS actors and their international counterparts matter? Why does it matter that knowledge sets, expertise, and experts themselves shuttle between jurisdictions, sectors, and jobs in the efforts to institutionalize CCS? The material in the chapter demonstrates

two answers to this question: first, CCS operates as a political technology through a movement of governance functions from the state to a wider set of actors, and second, such governance formations engender a flow of knowledge back to the state.

Many scholars have noted that as the powers of governance at a range of scales have increasingly shifted towards private institutions, arm's-length public institutions, and non-governmental service providers, arrangements of governments with 'partners' have become normal (Cox and Mair 1988, Swyngedouw 2005, Larner and Laurie 2010). The RFA was a government process that relied extensively on the participation of many actors not beyond the geographical jurisdiction of the province, but also beyond the state itself. Through the extensive consultation and collaboration with actors outside of government (or its porous borders), this account of the RFA suggests that carbon control is being carried out through extensions of new actors, new forms expertise, practices, and new spaces of knowledge production and decision-making. Thus, the 'science-policy interface' (Chilvers and Evans 2009) of carbon capture in Alberta reveals that the regulation and management of climate change and its challenges extends far beyond, yet is still thoroughly anchored to (evolving) institutions of, the state (Swyngedouw 2005).

Thinking through the "complex, multi-national and multi-scalar networks of climate diplomacy and energy collaboration of organization involved with CCS" (de Coninck and Bäckstrand 2011) can help scholars and researchers of climate change gain a better understanding of how expertise, knowledge and regulation are co-constituted in contemporary climate change politics. In this and the previous chapter, I demonstrated that in order to account for the place of CCS in the world today, one needs to understand how the technology becomes both a product of, and productive of, particular social arrangements. For Kuus, "the task for an in-depth study of a social phenomenon is not to focus on its object …as such, but to examine the *social space* from which the object of analysis derives its distinctive, differential and relational properties" (2011b: 425). This chapter has shown the RFA as a social process which has helped produce not only knowledge about

how CCS ought be best regulated, but also both articulates with existing networks of personal and professional affiliations, inter-sectoral and multi-scalar collaborations, and in the process produces new social arrangements.

I also showed that in many cases, Alberta's carbon control crisis occurs within a context of channelized decision-making, which leads actors to promote a carbon mitigation technology that fits within the existing political economic-knowledge complex of the province, which is dominated a hydrocarbon development strategy. Stephens et al. (2011: 389) describe this process as "technological advocacy," which they argue is a necessary part of the any innovation process. They describe technology advocacy as the "fundamental mission" of both the Carbon Sequestration Leadership Forum and the Global CCS Institute, and argue that many in the international CCS community possess a "positive bias towards CCS because of personal efforts to develop CCS" (2011: 38, see also Shackley et al. 2009).

The notion of technological advocacy for CCS enables me to come to a central finding of the dissertation, alluded to in Chapter 2: since CCS is promoted by a community of actors to the extent that these actors believe it supports their goals, CCS enables a continuation of what scholars call a 'path dependence' of fossil fuel dependency not only at the political economic level, but also on the level of knowledge-production, as well as the career trajectories of experts, bureaucrats, and others. That is, CCS shows how 'structural'-scale path dependencies are cemented, at least in part, at the micro-social level.

CCS arose out of the existing organizational networks of Alberta's hydrocarbon economy: a culture of oil and gas in which entire career trajectories work for, and assume the dominance of, the continued exploitation of hydrocarbon products. I contend this gives actors a perceived narrow range of options from their subjective position, such that CCS appears as the only option for achieving emissions reductions. It is a fix conceived within existing paradigm, which helps to strengthen the path of that paradigm at both the structural and epistemological level. Barry would

call this path “defensive innovation,” defined the avoidance of significant techno-social change as a direct or indirect political or industrial strategy (Barry 2001: 212). The next chapter will explore how the intellectual labours of the various proponents of carbon capture CCS worked from within the fossil fuel paradigm to frame CCS as a crucial climate change strategy. It will also show how some of the blinders of this paradigm have contributed to the “notable lack of CCS” in Alberta, and beyond.

Chapter 6: Storylines, Models, Specters and Vacuums: Discourses of Technology and Technologies of Discourse

"The words you speak become the house you live in."

- Hafiz of Shiraz

"[S]cholarship functions as a weapon … descriptions that purport to define reality can be used to influence politics and political legitimacy."

- Yves Dezalay and Bryant G. Garth

6.1 Dialects of Technology

At the beginning of chapter 4, I set out a conceptual framework through which one could understand why and how CCS is being constructed as a political technology in the form of a 'fix' for three interrelated crises facing Alberta's fossil polity. This entailed examining the gradual construction of a new technological assemblage – CCS – that would enable the Alberta government and its associated allies to manage the province's emerging climate change associated problems. The three dimensions of this fix are: (1) the construction of a new object of regulation (CCS) and proponent community translation from prior oil and gas systems, discussed in Chapter 4; (2) the additional composition and institutionalization of the new object and its community with the inclusion of regulatory analogues, and new expertise and knowledge (Chapter 5); and (3) the construction and composition of discourses, scientific narratives and policies about CCS that would serve to channel interested allies, funding, and attention to the new object.[132] This chapter is about

[132] For Mosse, the multiplication of interests (enrollment of actors) (discussed in Chapters 4 and 5), as well as the construction of representations (the papers, the final reports, meeting minutes, engineering drawings, promotional materials) (discussed in Chapter 6), are one and the same. For the purposes of exposition we separate them as two

the latter component – the discursive elements, narrative constructions and policy components that form a necessary part of how CCS is able to serve as a political technology for actors to manage the complex problems of carbon in the age of climate change.

Why does the way CCS is written about and talked about deserve explicit analysis? A clear example of the importance of discourse to CCS is illustrated by comparing the large and expanding amount of writing about CCS to the number of operating projects. Despite two decades, a dedicated academic journal, industry publications, international conferences, international networks and institutions dedicated exclusively to carbon capture technology, as of early 2015, there are still currently only three dedicated geological storage projects in the world (Global CCS Institute 2015), a number unchanged since I first began researching the issue in 2010. In Alberta case, the first dedicated CCS project only began operating in the fall of 2015. And yet despite the paucity of 'actually existing' projects, both globally and in Alberta, one can say that CCS has nonetheless already produced important impacts and effects in the world.

This chapter takes as a starting point the contention that narratives, discourses and interpretive frames are necessary components of any collective effort to bring into existence new social objects. This chapter will show that discursive elements not only enable technologies to be brought into being, but also help constitute the technology itself.[133] Narratives or 'storylines' (see Chapter 2) about CCS are integrated into scientific, research and academic efforts, as well as policies, reports, and media. In order to understand how technologies such as CCS are advanced as climate change mitigation options, it is necessary to understand how they first become embedded as scientific and policy narratives, and how they become both products of, and productive of, particular social arrangements. I take science, policy, and the science-policy interface to be

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different 'cuts' that allow us to view the myriad of smaller political technologies that constitute carbon capture as a coherent techno-discursive object.

[133] We can say that carbon capture acts as a political technology because it is itself a composition; it is an idea-thing/techno-discursive object which operates as a seemingly discrete object, only because actors are working, through a variety of other political technologies, to *compose* it as a such.

"particular social and cultural worlds or 'domains of meaning'" (Shore, Wright and Peró 2011: 1), which not only reflect the world they observe, but also create these worlds as well. Through emphasis on the discursive dimension of carbon capture and storage one can understand some of the processes and activities related to CCS investigated in prior chapters – science and engineering, economics, government, and policymaking – *as discursive endeavors.* This chapter will show that each of these domains of knowledge contributed to a "consensus story-line" about CCS.

Since our goal is to understand how CCS operates as a political technology, and our contention is that is does so by acting as a technological fix that temporarily reconciles competing political economic strategies within a political formation, this chapter aids an understanding of whether CCS has succeed or failed, but moreover, *how* it might succeed (or fail), and with what consequences (Mosse 2004). Together this means I will explain how the particular domains of expertise and knowledge, and certain key storylines, intersect with the larger political economic field, and what is produced as a result.

The chapter proceeds as follows. Section 6.2 empirically details storylines employed by actors in the CCS network. These discursive elements - bridging technology, stabilization wedges, deference to models – not only position CCS as a desirable scientific endeavor and legitimate development pathway, they also help position CCS as a *necessary* technological undertaking. Section 6.3 outlines how, at the current historical conjuncture, both internationally and nationally, the dominant conception of CCS presents serious barriers to the actual deployment of carbon capture. Specifically, I argue that the science community and the policy community's use of a techno-economic paradigm misrecognizes both the need for carbon capture in the climate mitigation mix, and the role of government regulation in bringing about the scale of carbon capture deployment that models of carbon capture projected. In the final section, I suggest that the apparent failures of carbon capture force me to define new terms of success for carbon capture. I argue that since carbon capture has been advocated by communities primarily as a fix to overlapping crises, the

'success' of carbon capture policies needs to assessed on the basis of whether it successfully temporarily reconciles competing policy demands.

Attention to the discursive aspects of carbon capture will lead me to a central argument of the dissertation - that technologies are inextricably constituted and conditioned by both the meanings and discourses, and to the historical conjunctures in which they emerge. That is, they are products of their social contexts. This is important because it shows that technological formations are contingent – when technologies are articulated within different systems of meaning, or within different social contexts, they may take on a radically different valences, and may, depending on that with which they are articulated, produce radically different effects in the world.

6.2 Why CCS?: Key Legitimating Narratives in the Production of Discursive Carbon Lock-In

In this section, I detail some of the central storylines (see Chapter 2) that were circulated and uttered by Alberta's carbon capture actors. These storylines appeared in both textual form, and were used by respondents during interviews. I focus on the storylines that formed the foundations for justifying the pursuit of carbon capture in Alberta, what I call here the *key legitimating narratives.* Most of these storylines are also used outside of Alberta. I show that some carbon capture storylines originate from scientific sources were then circulated in policy circles (stabilization wedges), while others originate in economic and policymaking arenas and are then adopted in scientific practice ('business-as-usual' calculations). I conclude the section by arguing that all of these storylines help produce "discursive carbon lock-in," whereby carbon capture gets framed as a necessary technology in the course of the circulation of narratives about it.

Understanding how and why carbon capture serves as a technological fix for Alberta's carbon control crises entails apprehending the key legitimating narratives for its development.

Many of these can be drawn from the key policy documents associated with the institutionalization of carbon capture (such as the ecoENERGY Task Force and Alberta Carbon Capture and Storage Development Council final reports), as well as government press releases and associated news articles. I also sought rationales for pursuing carbon capture from those actors directly involved in its development. At the outset of nearly every interview I conducted, I asked respondents why carbon capture was being pursued, both in Alberta, and in the rest of the world. Common themes emerged many of which coincided with the legitimating narratives found in documents sources.

Table 6.1 Interviewee responses to why CCS being pursued.[134]

- As a means of addressing climate change and reducing emissions (9)
- Energy systems cannot be readily switched over away from GHG producing fossil fuel energy sources (8); Helps counteract predicted increases in fossil fuel production, emissions intensity, energy demand (3)
- CCS is a "bridging technology" to a lower-carbon energy system (2)
- Represents a significant "wedge" in required reductions (4); CCS is part of a suite of technologies for reducing emissions (along with renewables, efficiency, fuel switching, nuclear, etc) (5); Is not a "silver bullet" but represents a significant contribution to required reductions (2)
- Energy modeling and scenario building indicates its necessity (including IEA modeling) (4); It is an artifact of energy modeling, but circumstances have changed (1)
- "Makes sense"/is "logical" for the Alberta context – with large point source facilities, on the one hand, and endogenous expertise and/or suitable storage geology on the other (5)
- To "gain social license" to operate; "political desire"; optics (5)
- Is a means to reconcile a fossil fuel-dependent economy with the need to reduce emissions (4); Enables a continued high standard of living (2)
- Renewables alone are insufficient (2)
- There is no alternative (2); There is no alternative for certain types of large industrial facilities (2); It is appropriate for certain large facilities (2)
- The world may become carbon constrained in the near future (1); There are GHG targets to achieve and CCS is needed for these (1)
- Is part of innovation and technology export agendas (1)
- EOR provides cost recovery for carbon mitigation measures (1); CCS represents a "return on investment" for Alberta government (1)
- Smoke and mirror on the part of industry (1); responsibility on the part of industry (1)

The above list (Table 6.1) provides a complete inventory of rationales provided by respondents when asked, "Why is CCS being pursued? Both in Alberta and more broadly?"[135] For

[134] Numbers indicate how many respondents included this rationale as part of their response, which usually also included other rationales. Many of these rationales are highly interconnected, and any errors in the classification of the responses are the author's error alone.

the sake of streamlined exposition, I analyze only a few of these storylines: the "no easy switch" storyline (Section 6.2.1), the bridging technology/transition technology storylines (Section 6.2.2), the stabilization wedge storyline (Section 6.2.3), and the "models indicate" storyline (Section 6.2.4).

6.2.1 "No Easy Switch": Fossil Fuel Lock-In

When asked why carbon capture was being pursued, both in the Alberta and international context, the most common response I received was that carbon capture was being addressed as a means of reducing GHG emissions and addressing climate change. This is not surprising, since as seen in Chapter 3, carbon capture was developed in Canada in response to the possibility that federal government climate change commitments would necessitate restrictions on greenhouse gas emissions from large industrial processes.

The second most common response was that CCS is being pursued because energy systems cannot be readily switched over away from GHG producing fossil fuel energy sources. This is what I call the "no easy switch" storyline. This storyline uses a metaphor - that of "flipping a switch" – referencing an electrical device and connoting ease. The storyline is that moving away from a fossil fuel-based energy system is tremendously difficult and complex, and that carbon capture is necessary as an interim mitigation as a result. The "no easy switch" storyline is a condensation of one of three possible connotations, which were sometimes distinguished by interviewees and sometimes not.

The first connotation of the "no easy switch" metaphor condenses an argument about fixed past capital investments and infrastructural pathways. It argues that it is not possible to "flip the switch" rapidly to non-fossil fuel energy sources because of massive amounts sunk capital into fossil fuel infrastructure, both production-side (exploration, upgrading, transportation) and

[135] Most respondents provided several reasons why CCS was being pursued (providing between two and six reasons each), viewing the reason for the pursuit of CCS as a multi-causal. About two-thirds of respondents answered that the reasons for pursuing CCS were the same in the Alberta as other contexts.

consumption-side (e.g., natural gas furnaces, gasoline fuel vehicles, airplanes and marine vessels). It implies that even if full replacement for the world's energetic appetite were replaceable with renewable energy, the economic costs and "socially necessary turnover time" of renewable energy infrastructure would make a climactically timely switch impossible. One of many respondents that used this storyline thusly:

> I35: *Contrary to belief in some corners, we can't flip a switch and move over to …whatever this sustainable technology is that's coming next, because it hasn't been invented yet that can operate at the scale or deal with the existing infrastructure. There's no easy transition…*

The second connotation of the "no easy switch" storyline is one of increasing demand. In this case "no easy switch" connotes that predicted increases in energy demand, in particular in the developing world (especially BRIC countries India and China) are large enough to necessitate continued, or even expanded, use of fossil fuels, and thus a switch away from fossil fuels would deprive developing nations of their right to energy.

The third connotation of flipping the switch is essentially a question of convenience, and suggests that countries that can continue to use domestic fossil fuel reserves, will.[136] It was exemplified by this interviewee:

> I3: *…it is important to understand that, although alternatives and renewables, energy efficiency, … all that stuff is great and we should keep advancing on those technologies, we can't flip the switch. I'm sorry…but we WILL be burning fossil fuel – like, gas is so cheap right now. Coal is cheap. We're finding more and more oil all the time […] So I see us still using fossil fuel reserves as our primary source of energy for at least next 20, probably*

[136] This connotation operates with an assumption that decision-makers will opt for lowest-barrier economic and political decisions, but also presumes that lowest-barrier decisions will be automatically be pro-fossil fuel decisions.

more like 50 [years]. … So, recognizing that we can't switch our fuels today, … what else can we do with all these emissions?... Right now the most viable technology is CCS.

6.2.2 "A Very Long Bridge Indeed!": Bridging Technology and Discursive Carbon 'Lock-In'

The "no easy switch" storyline is associated with, and can be considered the underlying premise of, two similar CCS storylines: the storyline "interim/transition technology" and the "bridging technology" storyline. The basis of both of these storylines is that since there is "no easy switch" away from fossil fuel energy systems, CCS can help reduce GHG from fossil fuel-based systems in the interim, as a temporary measure that enables carbon reductions on the existing system to be achieved while low carbon infrastructure is built up. As such, carbon capture acts as a "bridge" between the old fossil fuel system, and newer, low-carbon systems. One respondent described CCS as a transitional technology in the following way:

EK: *Why is this a technology that's being pursued …?*

I26: *I guess because its an important transitional mitigation measure, given the extent to which we're all still in love with carbon. So, I don't think of it as a long-term solution. I think the long-term solution is undoubtedly another energy source, such as hydrogen.*

In providing this rationale, I26 was sure to point out that CCS is a short-term solution. Similarly, another respondent also rationalized CCS based on the transition technology storyline, describing it as a "stop-gap":

EK: *Why is CCS an option that Alberta is pursuing?*

I6: W*ell it will fill the gap until technology is able to … help us reduce emissions that we really need to reduce… So, we're working to help technology do a step change and this is a*

stop-gap. So CCS has the ability to take quite a few tonnes and it's near term. It seems that we can do this right away, so that's why.

It is worth noting that the transition technology storyline appeared in early on documents about the potential for CO_2-EOR in Alberta, with government and utilities actors describing CO_2-EOR as an "interim technology option to allow the necessary ongoing, environmentally friendly use of existing energy infrastructure" (Legg, McDonald and Wilson 2000: 1061).

As suggested above, the transition technology storyline is functionally equivalent to the "bridging technology" storyline, which several respondents gave:

I35: *So … if we're serious about addressing carbon emissions, CCS has to be part of the transition to some future sustainable state… It's a way to take action early to get us to bridge to a future sustainable state.*

Another respondent described CCS as a bridging technology, and was emphatic that their perspective was a consensus view:

I32: *I kinda share the opinion that most people have – is that CCS, while it has its challenges …it's a bridging technology that allows us to some decarbonization of the energy system and electrical system… And then hopefully in sixty, …hundred year time frame …. – all of the smart people… will have actually solved some of these problems. So …my view's not any different than most … it serves as a bridging off towards those longer-term solutions…*

The bridging technology storyline has been used by other CCS proponents in Alberta, and it is used extensively in CCS forums such as international scholarly literature on CCS, conferences and within transnational policies circles (Bäckstrand et al. 2011: 275; see also Maroto-Valer 2010: 88). The International Energy Agency (2008, 2009), the European Environment Agency (2011), MIT's "Future of Coal" Panel (2007), and others, have all advocated for CCS as a 'bridging technology.'

While the 'transition technology' and 'bridging technology' storylines might be considered near equivalents, they differ in two important ways. First of all, the transition technology storyline emphasizes CCS as a "stop-gap", "short-term", "interim" technology. The bridging technology storyline makes no specific claims to ephemerality. Secondly, while the transition technology storyline does not imply carbon capture itself leads to desired low-carbon systems, the specific imagery of the bridging storyline implies just that. The imagery of a bridge is an implicit claim that *CCS itself* acts as an instrument to 'pass over' the obstacle of high carbon systems to the other shore of low carbon systems.

The history, function and trajectory of carbon capture and storage, however, would suggest otherwise, and several parties have critiqued these storylines. For instance, one journalist argued that, "if it is to function as a bridging solution, it needs to be applied almost immediately" (Sherer 2008), in order not only to both to meet the urgent need for decarbonization, but also before the technologies that the storyline presumes are not yet poised to rapid scale-up – renewables and advanced efficiency technologies - reach market readiness. Carbon capture does not function as a bridging technology to low carbon energy systems because, in the context of institutions and collectives with limited resources to commit to climate change mitigation, investments in CCS are a competition with investments in renewables or efficiency. It is for this reason that some ENGOs, like Greenpeace are not in favor of carbon capture (Bradbury and Wade 2010, Wong-Parodi et al. 2008), claiming it would "come at the expense of renewable energy" (Sherer 2008). Likewise, environmental policy scholar Jennie Stephens unequivocally claims that, "CCS investments are dangerous as they further incentivize and legitimize continued use of fossil-fuels" (2014: 170). This contrasts sharply with the CO2 Capture Project's view of the relationship between CCS and renewables, which is that, "CCS is not a replacement for renewable energy build but instead aims to more quickly address carbon dioxide emissions while renewable energy capacity can be built and optimized" (CO2 Capture Project 2009). Furthermore, others argue CCS cannot act as a bridging

technology, because the other 'shore' has moved towards us: while limited progress that had been made in large-scale CCS deployment in the previous decade, renewable energies, especially solar power, have reached an inflection point, and are now technologically, economically, and politically available at reasonable cost (see below). As such, Stephens argued, "it will take longer to build this bridge than to shift away from fossil-fuels" (2014: 170).

It is worth noting that natural gas has been referred to with similar language – referred to as a "bridge fuel" by the IPCC (GasTech News 2014), a fact that many proponents of North America's shale gas hydraulic fracturing ('fracking') 'revolution' have highlighted in order to counter claims of its environmental demerits. But just as the shale natural gas boom has been criticized by scholars as "bridge to nowhere" in terms of mitigating climate destabilization (mainly because of high amounts of methane – a potent GHG – leakage from fracking installations) (Howarth 2014; also Brandt et al. 2014), so has carbon capture. Some scholars contesting the bridge or transition technology storyline on the grounds that it "locks in" carbon intensive systems, raise the question: "[i]s CCS more likely to function as a 'lock-in' for fossil fuels [than] a bridge to renewables…?" (Bäckstrand et al. 2011).

Gregory Unruh, a technology and sustainability policy scholar, introduced the notion of "carbon lock-in" to explain barriers to the diffusion of low-carbon technologies, as well as how fossil fuel-based infrastructures are perpetuated, in spite of their known costs and cost-effective alternatives (2000: 818). Carbon lock-in refers to the condition that "industrial economies have become locked into fossil fuel-based technological systems through a path-dependent process driven by technological and institutional increasing returns to scale" (2000: 817). One of Unruh's essential insights is that lock-in is not simply technological, but rather caused by "systemic interactions" *between* technologies and institutional systems where "positive feedbacks among technological infrastructures and the organizations and institutions that create, diffuse and employ them" (2000: 818).

For several scholars, although carbon capture and storage technology may *mitigate* greenhouse gas emissions caused by fossil fuels, it can only further 'lock-in', rather than bridge from, high-carbon fossil fuel systems. Engineering professor Mercedes Maroto-Valer, notes that if CCS is really to be called a bridging technology, an explicit "strategy to rid the energy system of CCS after it has contributed to bridging the time required" would be a necessary component of its techno-institutional design (2010: 88). Instead, she finds discussion and research into this avenue of the technology "largely absent" (*ibid.*). Technology assessment scholar Philip Vergragt takes Maroto-Valer's concerns further, arguing:

> "Even in the best case scenario, when investments in CCS would only be made in the period 2020-2040, coal would be used on a massive scale till at least 2080 (assuming a 40 year depreciation time). Beyond that date monitoring and safeguarding of CO_2 storage will remain necessary for an unforeseeable time… The 'bridge' technology would require a very long bridge indeed!" (2009: 18).

Thus for Vergragt, large-scale CCS installations would result in a "renewed 'lock-in' of fossil-fuel based energy technologies" (2009: 1). Vergragt argues that while the 'bridge'/'transitional technology' storylines are popular among proponents and advocates, these terms are "unknown in technology dynamics and innovation studies" (2009: 1).

I argue that while it is possible that physical CCS projects would cause carbon lock-in, it is just as relevant to consider that the justifying storylines like the "no easy switch," "bridging technology" and other storylines also produce *discursive* carbon lock-in.

6.2.3 Business-As-Usual, Stabilization Wedges, and the Production of Visual Storylines

This sub-section introduces a third storyline about carbon capture, a visual storyline – a model/diagram of the future that originated from a scientific source and became widely circulated in policy circles. I consider diagrams a storyline because, as some scholars have argued (Czarniawska-Joerges 1995, Lyotard 1979/1984), models, graphs, numerical data, and other components of scientific knowledge are, in fact, also based on narrative knowledge. In short, graphs and models are the way scientists tell their stories.

Referring back to Table 6.1, we can see that four respondents indicated that CCS was being developed because it represents a significant "wedge" in required reductions (a further seven respondents indicated it represents a significant contribution to require reductions). What are these respondents referring to when they speak about CCS as a "wedge," As does one respondent when referring to the Alberta *Climate Change Strategy* (Figure 3.3):

> EK: *Right. Ok… and so looking at the case of Alberta – why CCS in Alberta – as opposed to other places?*
>
> I26: *Because we're more in love with carbon than most. I mean, and clearly, as the provincial government, if you look at the wedge diagrams for Alberta, the provincial government is aiming to achieve its greenhouse gas reduction or stabilization targets, and its heavily dependent on CCS to do that.*

As did another:

> I3: *… the impetus for CCS to take off was really the 2008* Climate Change Strategy*. I assume you have that document? With the wedges? With the three pieces of that show that CCS should be 70 percent of our emissions reductions for 2050? So that's really the*

driver for why we're doing CCS… CCS is our big policy that will help us reach our emissions reductions.

The *Strategy* diagram displays the results of GoA modeling of desired outcomes for Alberta greenhouse gas emissions reductions, showing two tranches – "conservation & energy efficiency" and "carbon capture & storage" – which each contribute to an overall 163 Mt reduction in emissions by 2050. This particular visual display of greenhouse gas emissions mitigation models is a localized expression of a more widely circulated diagram – the stabilization wedge – one that I will argue acts as a visual storyline to legitimating CCS development.

The stabilization wedge diagram can be attributed to Robert Socolow, an engineering professor at Princeton. Socolow was also an "early advocate" of carbon capture as a key climate mitigation option, which he viewed as "[a] plausible technological approach … for the successful human management of carbon on a global scale indefinitely" (Socolow 1997:3). In the early 2000s Socolow became the co-director of the Carbon Mitigation Initiative, a project at Princeton University funded by BP and Ford (Campanella 2011: 39). At the time of his posting, he was a "relative outsider" to climate science, having spent most of his career on energy engineering issues (Kolbert 2006: 134). One of his goals as head the CMI was, as Kolbert relays, "to get a handle on the scale of the carbon problem" (*ibid.*). According to Kolbert, Socolow "found that existing literature on the subject *offered almost too much information*… a dozen or so alternative scenarios known by code names like A1 or B1, had been devised; these all tended to jumble together in his mind, like so many Scrabble tiles… [so] he decided to try to streamline the problem, mainly so that he could understand it" (*ibid.*, emphasis added).

We should note that most energy use and greenhouse gas emission mitigation projections rely on the production of a diagram that plots projected changes in energy use and/or emissions reductions measures, against a baseline scenario. This scenario is referred to as the "business-as-

usual: or "BAU" scenario. When Kolbert explains that BAU "refers to a whole range of projections, all of which take as their primary assumption that emissions will continue to grow without regard to the climate," (2006: 136-7) she conveys both that BAU scenarios tend to vary according to the agency or author that produced them, and that, despite the variation in projected energy demand and/or carbon emissions, most BAU projections assume both energy use and carbon emissions are on a upward trajectory.

Kolbert describes Socolow's process of constructing a diagram to understand emissions scenarios:

> "[s]tabilizing CO_2 emissions would be such an enormous undertaking that Socolow decided to break the problem down into more manageable blocks, which he called 'stabilization wedges.' For simplicity's sake, he defined a stabilization wedge as a step that would be sufficient to prevent a billion metric tons of carbon per year from being emitted by 2054. Since carbon emissions now amount to 7 billion metric tons, and in fifty years are expected to reach 17 billion metric tons, seven wedges would be need to hold emissions constant at today's level" (2006: 137).

Socolow and colleague Pacala devised fifteen 'wedges' that were each capable of delivering 1 billion Mt reductions. The stabilization wedge diagram depicted a linearly increasing BAU case where, C02 emissions are mitigated "through the application of a series of technologies, or "wedges""(Campanella 2011: 39), that in the aggregate equaled an absolute reduction. The pair published their findings in *Science* in August 2004 in a paper entitled "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies" (Figure 6.1). Both Campanella and Kolbert note that the stabilization wedge concept "had quick and wide uptake by actors in discussions of climate and energy policy" (Campanella 2011: 40). Indeed, both the GoA's 2008 *Climate Change Strategy* (Figure 3.3), and the Alberta Carbon Capture and Storage

Development Council used stabilization wedge diagrams in their reports, as did other Alberta actors.

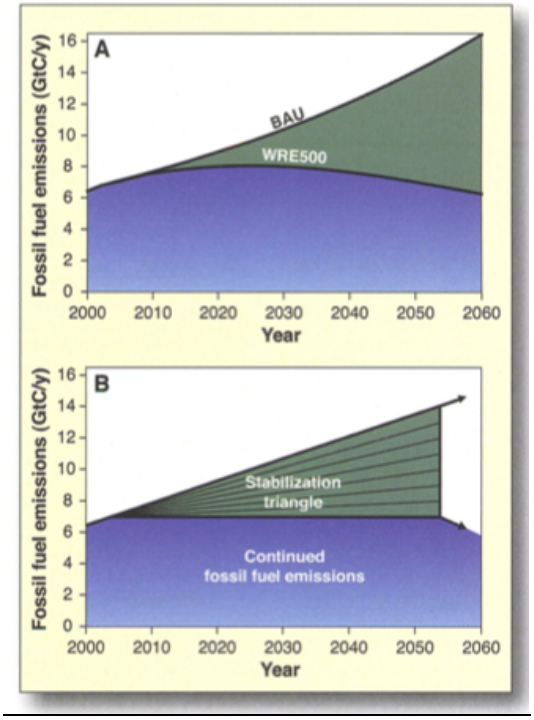

Figure 6.1. Pacala and Socolow's original "stabilization wedges" diagram.[137]

Stabilization wedges can be seen as what Latour calls inscriptions. For Latour, all science is a process of inscription, that is, a series of "transformations through which an entity becomes materialized into a sign, an archive, a document, a piece of paper, a trace" (1999: 306). In other words, just as much as science consists of a systematic practice of observation, prediction and explanation of observable phenomenon and entities, it also consists of the documentation/codification/inscription of those into the symbolic realm.[138]

[137] Diagram A indicates a top curve of projected "business-as-usual" yearly carbon emissions, and a bottom curve "consistent with atmospheric CO_2 stabilization at 500 ppm by 2125" (Pacala and Socolow 2004: 969). Diagram B represents the stabilization wedges, through an "idealization of … [a] stabilization triangle of avoided emissions (green) and allowed emissions (blue)."

[138] These two moments – observation and documentation comprise the processes of comprehension (Latin, *comprehendere*, from *com*- 'together' + *prehendere* 'grasp'), of which the moment of inscription represents the togetherness of explanation with the symbolic field.

In designating the stabilization wedges as inscriptions, one can see that they produce two desirable conditions for their authors and/or users: *simplification* and *stabilization.* Recall that for Socolow, the "dozen or so alternative scenarios" predicted for the future climate jumbled together "like so many Scrabble tiles," and "offered almost too much information." As the World Resources Institute describes in its 2005 publication on emissions stabilization technologies, stabilization wedges provide "a mental framework to discuss … solutions by breaking the required emission reductions down into *manageable* (though still large) 'wedges,'" (Wellington et al. 2005: 4). I argue that for its creators and users, the stabilization wedge diagram performs the service of simplification, which would help enroll a wider range of actors.

But the compelling nature of the simplifying function of inscriptions requires care in the case of predictive inscriptions, which are based off of the combination of observed phenomenon with a series of (albeit educated) assumptions or extrapolations. In these cases, assumptions or extrapolations necessarily mean uncertainty, and thus, inscriptions offer a second service. As Dambrin and Robson argue, "[i]nscriptions are also, however, valued for their stability" (2009). That is, diagrams also perform the service of rendering stochastic, or otherwise insufficiently characterized systems to be not only simplified but also stabilized, and therefore more amenable to rendered as the basis for claims, models, and so forth. In this sense, the stabilization wedge is, in fact, a double entendre; it refers to the stabilization of carbon emissions, but also to the stabilization of a particular image of predicted climate future – one in which the BAU assumption is "naturalized" and in which, "[t]he political and social forces determining energy use are mystified" as Campanella observes (2011: 39).

That stabilization wedges mystify, or reify, the underlying social and political economic conditions that contribute to energy use, demand, and supply is not unique in energy scenario planning. For instance, Bridge (2010) has made a similar critique of the ways in which the storyline of 'peak oil' storyline is premised on International Energy Agency projections of substantial

increases in energy demand and supply-side constraints. Bridge's central critique of peak oil models is that they represent, a "curiously asocial world … contain[ing] no feedback mechanism through which the social and environmental effects of the 'age of oil' could influence decisions about future production" (2010: 527).[139]

Anthropologist Arthur Mason furthermore contends that energy futures models produce an aesthetic fascination, constituting a form of stabilization through their very form as static images. He argues that they contribute to stabilization by "demonstrating *proximity* between existing energy infrastructure and … increased demand through *rising trend lines*" (Mason 2006), whereby the trend lines act as tethers from (known) present to (unknown) future, like a ribbon connecting a floating balloon to a solid base.

6.2.3.1 "We're Making a $50 Billion Promise with a $2 Billion Cheque": Predictive Inscriptions and Policy-Based Evidence-Making

I have just argued that the stabilization wedge storyline offers both simplification and stabilization for its producers and users. I turn now to a critique of the Government of Alberta's use of stabilization wedges, and the modeling work that produced them. The critique, offered by one of my respondents, helps to demonstrate that because stabilization wedges are predictive inscriptions, they have the potential to produce evidence and interpretations of the role of CCS in mitigating Alberta's GHG emissions problems that are inaccurate, leading to suboptimal knowledge upon which to based policies and decisions. At worst, they may be misleading, as I show.

[139] Part of the problem of the "curious asociality" of energy and climate models, argues Wainwright, is that *natural* scientists have been granted the greatest amount of social authority in studying and communicating about climate change – a thoroughly *socio*-natural phenomenon. He argues that, "[a]s many climate scientists have studied and spoken out about future climate scenarios—and *social* responses to environmental changes—they have become, *ipso facto*, social scientists" (2010: 984). Yet he raises the question whether because the modern 'monster' of climate change is thoroughly social and natural (Latour 1996, Weinberg 1972), scientists had taken for granted certain parameters of climate change, such as the feedback mechanisms of social and economic responses to climate change, or instead left them as static 'black boxes' (Wainwright 2010: 984).

During one interview, a respondent was discussing how several aspects of Alberta's energy landscape were different at the time of the interview (winter 2012/2013) than they had been when the *Strategy* was produced in 2008:

EK: *Given that the most recent GHG strategy was in 2008, is CCS still … appropriate [as a] 70% wedge?*

Respondent: *… I think given how much has changed... So natural gas when that was done [2008] was probably $8 a gigajoule, supposed to go to $20, and now its $3.50. So if you're looking at…a 1000 MW of coal fired power, … at the time when that was done, the cost over a 25-year lifetime would have probably been lower for building a [coal] CCS facility versus building gas plants. Now that situation's been switched: the cost … [of] coal with CCS is probably … above gas, and its probably now at the point where its above a well-designed gas and wind pairing. And so I think … the size of the wedges [in the Strategy] would change.*

The respondent was suggesting that the dramatic drop in natural gas prices from 2008 to 2012/2013[140] meant that building a new power plant with natural gas would be more cost effective than building a new coal plant with CCS. This rendered an assumption built into the modeling the Alberta government used for its 2008 *Climate Change Strategy* – that coal plus CCS was the most cost effective way for Alberta to achieve its GHG targets – now inaccurate. If the assumptions upon which diagrams like stabilization wedges are constructed are themselves *unstable*, a key effect of these diagrams is to present a particular future emission scenario stable, when it is in fact not. Thus, the policy option advocated for in the diagram - frozen in time with its attendant assumptions - still appears as appropriate, when it is not.

[140] A price drop usually ascribed to a flood of new supply initiated by the North American hydraulic fracturing (fracking) boom.

The respondent then went on to point out a further issue with the *Strategy* stabilization wedges:

> Respondent**:** *… The other thing: just because you draw a bunch of wedges, I think you have to go back and say, "What actually drove those? Like, where did those wedges come from?" Right? And those wedges … are outcomes of a particular policy. Right? So if you go into … the modeling report that developed the* Climate Strategy*… [A] whole series of policies that were modeled as part of that … Those wedges come out of [a scenario]… where you have something like $150/ton carbon price, carbon tax. Not an …SGER type price,*[141] *but a straight carbon tax, plus a requirement that all new facilities in the oil sands and for power gen be equipped with carbon capture and storage… Well sure. There wasn't a question of "What's the cheapest way to get to a particular GHG reduction?" … It was "What was the outcome of a particular set of policies"?*
>
> EK: *I have to admit, you're going to have clarify…*
>
> Respondent: *Sure … so basically when you see that wedge in the* Climate Change Strategy*? That wedge diagram is essentially the answer to a question. And the question is "What would happen IF in Alberta IF we put in place $150/ton carbon tax, AND a requirement for everybody to built CCS and new building efficiency standards AND a whole bunch of other stuff?" If you did that, what would happen? A bunch of people would use CCS. There'd be a greener electricity supply. It would be more efficient. Right?*

The respondent was indicating two things. First, that the diagram was the outcome of a modeling scenario, which I call Scenario X (which assumed $150/ton carbon price + carbon tax + CCS-equipped requirement for all new oil sands and power facilities). But this scenario is not

[141] The SGER (Specified Gas Emitters Regulation) price on carbon is $15/ton carbon price, based on emissions intensity, rather than absolute emissions, for facilities producing >100,000Mt CO2e/year.

reflective of the *actual* climate practices of the GoA ($15/ton carbon price + carbon intensity targets for facilities >100,000Mt/year). Second, the model was not based on "least cost scenario" objectives, contrary to the GoA's stated priority. I asked for clarification on how many of those assumptions are translating into actual conditions:

> Respondent: *So that's the important thing to understand about that wedge is … I mean, it's put out there as "This is how you would get to that goal," but it actually isn't that. It's an answer to a question of, "If we did those policies what could happen? We asked a bunch of consultants, this is what they told us."*

To reiterate, the respondent indicated that the wedge diagram produced for the *Strategy* was not a diagram reflecting the anticipated impacts of the government's plans. Instead, it was diagram of what GHG reductions would result from a Scenario X, a policy suite that the government has given no indication it ever intended to pursue.

Finally, the respondent continued with a further critique. Not only was the produced wedge diagram based on incorrect commodity prices assumptions about natural gas, and based off of a policy scenario that differed greatly from the actual policies of the *Strategy*, it was also based on the assumption of large increases in oil sands production levels:

> Respondent: *The other issue that buried under that wedge is there's one assumption to how that turns out. And it's that oil sands production stays as forecast… [to] increase dramatically.* […] *So you get these huge CCS numbers… a whole bunch of CCS. If you uncouple that, …allow them to say, "Only build new oil sands facilities if it makes economic sense to do so with CCS deployed," you get less CCS. In the [background] modeling work there's a graph for what happens under a policy like the SGER $15/ton policy. It's not 140 Mt of CCS. Wow, it's like 1 Mt…*
>
> EK: …*which is kind of what we're [currently] looking at.*

By displaying a particular set of model parameters using a "stabilization wedge" visual, the Alberta government created a vision of the role of CCS among options in which it would produce massive reductions (139 Mt), and in which it would be the only option capable of enabling abatement in an increased energy production scenario. Yet these model parameters did not reflect Alberta's actual policy conditions. The stabilization wedge was not the answer to the question, "How much and what type of emissions reductions will our *Strategy* produce?" Instead, the diagram was the "answer" to a different question – along the lines of, "What model parameters need to be entered to produce a stabilization wedge diagram in which CCS is shown to be a predominant mitigation strategy, as well as a technology that can cut absolute emissions in an increased energy production scenario?"

Thus, I argue, the stabilization wedge is itself a storyline. It is a condensed narrative of social reality that provides "actors with a set of symbolic references that suggest a common understanding" (Hajer 1995: 62). Yet in the case of Alberta, the symbolic references were used, it would seem, to intentionally create common *mis*understanding. In this sense, the *Strategy* stabilization wedge was flawed not just for errant *forecasting* (incorrectly assuming high gas prices and oil sands expansion), but also misleading through "backcasting" (Mason 2006).[142]

This appeared to be the conclusion of the Office of the Auditor General of Alberta (OAGA) (Calgary Herald 2014), which conducted an audit on the *Strategy*. The OAGA concluded, "that the targets were based on an economic model that anticipated actions that were not part of the strategy" (2014: 39)[143]. According to the OAGA, "with only two carbon capture and storage projects

[142] While backcasting is meant to identify a desired future state, and works backwards to identify the policies and actions that will lead to such a future from the present, ESRD identified a desired future state, and a scenario that could lead to such a future, but failed to make any links between that scenario and its actual policies programs that will connect the future to the present.

[143] It also concluded that the Department of Environment and Sustainable Resource Development (ESRD), "did not have a plan that identified specific actions to meet the targets and monitor the results," nor was there evidence that the department "regularly monitored performance between 2008 and 2012 against the 2008 strategy targets" (Office of the Auditor General of Alberta 2014: 39).

planned, the total emissions reductions are expected to be less than 10% of what was originally anticipated" in the *Strategy* (*ibid.*: 40).

My respondent's insights and the OAGA's assessment are supported by some of Mosse's observations about implementability of policy: that "policy … primarily functions to mobilize and maintain political support, that is to legitimize rather than to orient practice" (2004: 48). If that is true about policy, it is also true about the evidence used to construct policies. Thus, not only can diagrams, models, graphs, calculations, as well as the technocrats and consultants who construct them, serve to legitimize rather than inform governance decisions, they are also powerful strategic devices for persuasion and actualization. Inverting the concept of evidence-based policymaking, a much-touted set of policymaking practices (Belluz and Hoffman 2015), geographer Jamie Peck has used the term "policy-based evidence making" to refer to the increasing common trend in policymaking circles to use evidence selectively to justify preferred positions, using data in narrowly instrumentalist, or obfuscatory ways.

Diagrams like the stabilization wedge are particularly potent storylines because they are quantified, and thus tend to be granted a form of social legitimacy that non-quantified data do not receive (Mann 2007: 148). Thus, the stabilization wedge storyline derives its validity from its particular form – simple, quantified, visually fascinating, as much as, or more so than, from the validity of assumptions underlying it. Deleuze and Guatarri evoke another potency of the diagram, contending that, "[t]he diagrammatic or abstract machine does not function to represent, even something real, but rather constructs a real that is yet to come, a new type of reality" (1987: 142). This points to the role diagrams, models, policies and other social texts play not only in describing the world as it is, but in describing the world as it might be, and in doing so, initiating a concretization of a vision or strategy.

One of my respondents described the effect of this strategy thusly:

> Respondent: *Governments tend to like, "Well, I don't want to spend $20 billion but I sure like the outcome from spending $20 billion. So I'll spend $2 [billion], but I'll promise to outcome of $20 [billion]."... that was basically the conclusion of the [Auditor General's] report. That the government ... had a whole bunch of modeling done... And in the* Climate Change Strategy*, they published the outcome from a really stringent policy and they implemented a ... relatively weak policy... $2 billion is a huge amount of money... But it's not going to get you 20 Mt by 2020, no matter how you work the math... And so my take had always been, "Were making a $50 billion promise with a $2 billion cheque."*

The respondent's critique reveals that the nitty-gritty details of numbers, charts and diagrams are important because they are not "merely technical" but form crucial bases to claims, which are granted social authority because they are quantified or appear technical (Greenhalgh 2008: 30). This is one of the ways in which science can serve to legitimate policy. The work of two key climate and energy institutions – the Intergovernmental Panel on Climate Change and the International Energy Agency, has also been used to advance pre-existing policy goals on CCS, rather than to orient them.

6.2.4 "Climate Wizards": The Legitimating Role of the IEA and the IPCC

This final subsection explores a fourth storyline that was used by my interview respondents to explain why carbon capture is being pursued in Alberta. This storyline, which I call the "models indicate" storyline, suggests that carbon capture is being pursued because particular models, and agencies who produce them, indicate that it will be necessary. It is a narrative that legitimizes the need for CCS based on the results of various modeled climate and energy scenarios. And it is a dislocatory storyline because it creates a distance between the user of the storyline and the source of authority the user cites. While the stabilization wedge ascribes authority and truth the model

itself (either obscuring or reifying the model assumptions, margins of error, and uncertainty), in the "models indicate" storyline, the user ascribes the authority of the storyline to an external, 'higher' authority.

During my interviews, the "models indicate" storyline was used as part of the response to "why CCS" by four different respondents. Three indicated that International Energy Agency models justified the pursuit for CCS, while another respondent, a Shell representative responded that carbon capture was necessary because the company's own in-house long-term energy models, the *Global Scenarios*, indicated a global increase in energy demand:

> EK: *… why CCS? Why now? Why here? Why in general?*
>
> Shell Representative: *… climate change has …been recognized as an issue that needs to be addressed as a society. And as a responsible member of society, Shell believes … an obligation in our company to be a part of that solution. So what Shell does is we – we're scenario based company. We spend a lot of time doing our um...* Global Scenarios – *long-term scenarios that are 30, 40, 50 years out there…In all scenarios that we play out, … there's no doubt that all involve more energy requirement… So … when you look at mid century – 2050 – we're projecting about double the energy requirements.*

In a 2010 paper, Zalik explored the relationship between oil industry representation of current and future operating conditions and oil futures markets. Using Shell's *Global Scenarios* publications, Zalik found there was a relationship between futures markets "and the social perceptions that shape them," arguing that actors' predictions about prices become part of the very social conditions that influence prices (2010: 554). In arguing that a Shell *Scenario,* "through its very expression intervenes in the social perceptions that condition speculative markets," (*ibid.*), she made the case that for the *Scenarios* and other business discourses in the energy field are "strategic," having the effect of shaping the dynamics of

energy markets in ways that advance companies' business interests (2010: 563; see also MacKenzie, Muniesa and Siu 2008).

Zalik also argued the same about IEA's *Outlooks*, which similarly influence social perception of energy markets, and in the process, the dynamics of the global oil market itself (2010: 562). If IEA's energy *Outlooks* can change the global oil market, can their publications on CCS similarly shape the dynamics of carbon capture and storage development? My findings, supporting Bäckstrand et al. (2011: 277), showed that the IEA's projections of the role for CCS to help achieve global emissions reductions contributed to the legitimacy of the pursuit of CCS for Alberta actors. One respondent, when asked why CCS was being pursued responded:

> I9: *[…] every credible forecast that I've seen says that fossil fuels are here for the next four decades. So if we don't do anything for four decades, it's gonna be too late.*

So whose credible forecasts was I9 examining? One of them was the IEA:

> I9: *Well, I think that it's … you look at the sort of climate wizards and what they think – and I'm referring mainly to the IEA here – and their take on CCS - is that it is it's got to be a necessary part of a suite of technology…in of itself it doesn't solve the problem, but makes a significant contribution to some industrial aspects, and the power side.*

Two other respondents also indicated that CCS was being pursued because of modeling work done by experts at the IEA, one of whom stated:

> I19: *… the International Energy Agency puts out their …* Scenario *mapping as to how the world is going to get their two degrees scenarios … by 2050 … Well, they show that… we'll need CCS to capture … 20% of the effort.*

The Intergovernmental Panel on Climate Change (IPCC) has also been key for advocating for the pursuit of the technology. In an analysis of the creation of the 2005 IPCC *Special Report on Carbon Dioxide Capture and Storage* (Special Report), Narita sought to answer how the IPCC managed its assessment of CCS,[144] given that, as a relatively novel technology, the viability of CCS as a mitigation technique was both "highly uncertain and also politically sensitive" (2010: 5). Narita closely examined the process of the writing the 2005 Special Report and concluded that it was associated with two political goals. One of the report's main editors, Bert Metz, recalled that it would be useful for the IPCC to produce a report in order "to provide a common ground for future policy debates on CCS," given that CCS was becoming an increasingly contentious issue for energy experts, environmentalists and policymakers (*ibid.*). The other goal was to alter what was perceived as a deadlock in international climate policy negotiations, whereby by evaluating a technology "that would not alienate fossil fuel interests but was inclusive of them," (2010: 7) might help advance stalled talks.

It should be noted that the role that the legitimating role of the IEA and the IPCC Special Report are not separate. Campanella details the relation the IEA- GHG Programme had on the IPCC's position on carbon capture:

> "[i]n its Second Assessment, published in 1996, the IPCC gave little weight to CCS and, while noting the negative impacts on electricity costs and energy efficiency, viewed its long-term potential and effectiveness as "largely unknown" … But by the Third Assessment of 2001, the conclusion was much more favourable and based largely on research done by the IEA-GHG, listing several IEA-GHG members as contributing authors" (2011: 39).

[144] Narita notes that, in the history of the IPCC's work, "it was unprecedented to make a comprehensive report specifically dealing with a single technology" (2010: 5).

After the Third Assessment, the IPCC was asked by the United Nations Framework Convention on Climate Change to further investigate CCS. The IPCC obliged for the sake of providing a "common ground" for policy discussions among supporters and detractors alike (Narita 2010: 5). Markussen, Shackley and Evar suggested that the IPCC's 2005 Special Report was a "key event" in the history of carbon capture, whereby experts contributed to "legitimizing the technology and giving it credibility" (2012: 2; see also Meadowcroft and Langhelle 2009: 267). According to Vergraght, the report was an "important element to create a more positive attitude for CCS internationally" (2009: 13). He argues that, "although it was a scientifically 'neutral' report," it presented CCS as a viable mitigation option, and thus was "instrumental" legitimizing CCS (2009: 13, 14).[145] Thus, despite some internal division on the panel (Narita 2010) (explored below), which was made up primarily of geologists (representing governments, research institutions, industry and NGOs), and personal misgivings from its authors about over-optimism that could be garnered from it, the IPCC document acted as a "foundational and oft-cited report" (Campanella 2011: 43), and has also played an important role in the legitimation of CCS as a climate change mitigation tool, including in the Alberta case.

For instance, in response to an article critical of Alberta's CCS agenda by Andrew Nikiforuk, ICO2N referred to the IPCC report in order to refute Nikiforuk's claims that CCS had outstanding safety and efficacy issues. ICO2N argued that "[e]ven the IPCC, a group well known for its effort to quantify the risks of future climate change," gave estimates that over 99% of CO_2 "retained in appropriately managed geological reservoirs would remain for 1000 years"" (ICO2N 2011). It turns out this very phrase, which ICO2N had cited verbatim – "retained in appropriately managed geological reservoirs would remain for 1000 years," was itself the biggest source of internal

[145] Vergraght contrasts the positive attitude towards CCS the IPCC report made possible with the views of Dr. Leo Meyer, head of the Technical Support Unit of IPCC Working Group, and an editor of the report. Dr. Meyer warned in a personal capacity "against too much optimism about CCS" - which Vergragt suggests as "a remarkable position for somebody who has played an important role in producing the IPCC CCS report" (2009: 14).

division on the Special Report Panel. One of the central goals of the Report was to make an assessment of the permanence of underground C02 storage. As Narita explains,

> "Given the very limited field experience, [an assessment of the permanence of underground C02 storage] was in some sense an unanswerable question – it was not straightforward to draw conclusions about the security of underground storage from existing scientific evidence. Still, the authors did not have the freedom to be agnostic about this question as this was one of the issues that policymakers were most interested in" (2010: 9).

In an interview Bert Metz articulated that knowledge of storage capacity (how much carbon dioxide could be stored) and permanence (that the CO_2 would not leak) were "absolutely essential for policymaking," and recalled "that the IPCC management team "made really clear we need some statement that is meaningful" on this issue" (Narita 2010: 9). And yet the panel found itself without enough data to make these very assessments. The team had "soft information" supporting long-term security of $C0_2$ storage: their geological expertise furnished them with confidence about natural trapping mechanisms in underground geological formations, which had successfully trapped oil and natural gas for eons, as well as knowledge of limited, but positive evidence of large-scale $C0_2$ storage from projects like the IEA-GHG Weyburn-Midale CO_2 Monitoring and Storage Project.

The team, however, needed to *quantify* the security of underground carbon storage, in a situation in which accurate quantification was not possible. The Special Report authors eventually found the path to quantification through the adoption of an "expert elicitation method" (*ibid.*). This method, which is used when scientists and engineers wish estimate values in the absence of direct observational data, involved the completion of an anonymous questionnaire by authors of their "best guess" at probabilities of storage security (subjective evaluation), and the selection of the

"most representative numbers" from answers (*ibid.*).[146] The result was "a clear quantitative assessment about security of underground storage with specific numbers" (*ibid.*) – "99% of CO_2 retained in appropriately managed geological reservoirs would remain for 1000 years." However that figure was, in fact, a quantification of "best guesses," that came without any definition of what constitutes "appropriately" (*ibid.*).

While all authors ultimately agreed to the use of the method, not all agreed about the validity of quantitative estimates produced from the method. One of the study authors, a geologist by training, working for an ENGO, was concerned, in her words, that, "if we did it [presenting quantitative estimates], then this would be used everywhere" (*ibid.*). Her concern has panned out: the figure has been used frequently since, as the SRCCS receives numerous citations for its assessments in academic and other publications. Yet while the quantified assessments of the IPCC Special Report were widely circulated, the conditions of their production were not (Narita 2010: 15). The IPCC Special Report therefore, seems to be another instance of policy-based evidence making, whereby the imperative to meet two political goals (providing common ground for policy debates, and evaluating a technology that included fossil fuel interests) preceded and dictated the terms of production of evidence, creating pressure for quantified data where is was perhaps inappropriate.

6.2.5 Strategic Networks, Enthusiastic Proponents and the Specter of the Reluctant Advocate

I have just presented the relationship between the production of scientific and technical storylines – which delineates what is thought and said about carbon capture – and the policy/political realm – which delineates what is 'doable' with respect to carbon capture, in the

[146] The expert elicitation method is not without controversy; there is debate as to whether it constitutes acceptable evidence (Jasanoff 1990: 108).

process refining by what is meant by my claim that carbon capture operates as a political technology. Thus, I argue, through the production of models, diagrams, and storylines, and through the work of stabilization and simplification in work such as the IPCC Special Report, a critical mass of expert claims come to constitute the emergence of a common sense about CCS where none previously existed. This common sense emerges within and between actors involved primarily in knowledge production and those involved in policymaking. In the case of CCS, many of those experts who might be considered core constituents of any CCS epistemic community are energy professionals, including a large share whose expertise lies in fossil energy.

And yet fossil energy constitutes only one part of the sum total of knowledge about energy systems. The epistemic frameworks of energy professionals has been previously explored by several scholars, including anthropologist Laura Nader. In the 1970s, Nader observed that groups of energy technology experts tended not only towards "standardized thinking" about potentials and pitfalls specific energy technologies, as discussed just above, but furthermore a lack of respect for a diversity of perceptions, including alternative energy technologies (Nader 1981a).[147]

In the concluding chapter of their 2009 book on carbon capture, Langhelle and Meadowcroft provided an overview of the path and trajectory of carbon capture and storage technology globally since its emergence. They addressed how discourse about CCS in political and policy circles has evolved over time, noting the variety of "the relative place it should assume in (regional, national and international) mitigation portfolios" (2009: 268). Meadowcroft and Langhelle created a typology of four distinct CCS storylines:

a) "consensus storyline," based on the supposition that, "CCS makes sense as a response to a very particular societal dilemma: a coupling of the realization that GHG emissions pose grave risks

[147] Another scholar of energy policy writing in the late 1970s, Amory Lovins, argued that high technologies – like nuclear and fossil fuel power - because of their complexity tend to demand "dedicated constitutencies," who come to link the success of these technologies with their own. For Lovins, "[s]uch sincerely held beliefs, peer pressures, and the harsh demands that the work itself places on time and energy all tend to discourage such people from acquiring a similarly thorough knowledge of alternative policies and the need to discuss them" (1977).

to the global climate system with a need (or a desire) to continue exploiting fossil fuels" (2009: 287). They posit this story line as a hybrid of the,

b) "enthusiastic CCS proponent" storyline and the,

c) "reluctant proponent" CCS storyline (Table 6.2).

d) Finally there is the "critical" CCS storyline that advocates against using carbon capture.

Table 6.2 "Enthusiastic CCS proponents" and "reluctant CCS advocates" storylines.[148]

	"Enthusiastic CCS proponents" storyline	"Reluctant CCS advocates" storyline
1	Can't Flip Switch – Supply/Demand - fossil fuel will remain the foundation of global energy supplies for much of the coming century. This is especially true for countries with abundant remaining fossil reserves;	CCS is a solution and a problem - CCS is not without major problems and shortcomings
2	Can't Flip Switch - Infrastructural and financial fixed capital: society has accumulated vast experience …and has sunk hundred of billions of dollars into fossil-based infrastructure... So it would be foolish to turn our back on such resources, when CCS will allow effective management of the carbon emissions	Government Support/Subsidies Needed: care must be taken that governmental financial support for CCS does not starve renewables of capital, unduly favour a further expansion of fossil fuel dependence, and undercut the shift towards new renewables and non-carbon-based energy systems;
3	Renewables Insufficient: new renewables such as wind and solar suffer many disabilities … and they are unlikely to supply the bulk of the energy needs of growing economies in the foreseeable future;	"Arrow in the Quiver" (Qualified): mitigation efforts should clearly prioritize energy efficiency, new renewables, and other low carbon energy options, and only then turn to CCS as apart of the solution;
4	There Is No Alternative: CCS is a critical (and perhaps the critical) pathway to shift the world economy onto a low carbon emissions pathway	Transition Technology: CCS should be regarded as a 'transitional solution' that will be required only until other carbon-neutral technologies become available at reasonable scale and cost.
5	Innovation/Commercial Potential: CCS offers an enormous commercial potential for companies and countries that are first movers	Tool for Political Cooperation: CCS may be necessary to get some countries or sectors fully engaged with climate change mitigation;

For Meadowcroft and Langhelle, the divergent CCS storylines can be accounted for by divergences among actors' perspectives about the urgency of climate change, and the merits of alternative energy supplies. It is appropriate that Meadowcroft and Langhelle developed a storyline schema in which the dominant (consensus) storyline is a partially overlapping hybrid of the enthusiastic proponent and reluctant advocate storyline. It demonstrates that, rather than representing a monolithic narrative, the consensus storyline was, *pace* Hajer (1995, 2005),

[148] Adapted from Meadowcroft and Langhelle (2009: 269-70). Underlined item titles added.

sufficiently malleable to be used by a variety of actors who might have fairly divergent interests[149]. I use Meadowcroft and Langhelle's designations "enthusiastic CCS proponent" and "reluctant proponent" in the rest of the chapter to describe Alberta's CCS actors.

The responses and viewpoints of many of my respondents lends support to my contention that many of the individual and institutional actors helping to pursue CCS are far from 'enthusiastic proponents.' Many are, instead, 'reluctant advocates,' even whilst using enthusiastic proponents' storylines. One respondent, for instance, who works full-time on CCS policy, shared that they thought the window of opportunity for CCS would be missed, and that this was not a bad thing:

> Respondent: *By the time we realize that we need to reduce emissions and …make a deep cut and do it fairly … If had to put it very succinctly it's that we're going to miss – that's CCS - that we'll miss the opportunity to use this technology. And I just want to be clear, I don't think that's a bad thing as long we're actually going to reduce emissions. I think that's the really important thing, you know, to do for climate change.*

This viewpoint revealed that the respondent's primary interest was in climate change mitigation, and that their interest in CCS was insofar as it could act as a mitigation measure. This normative position differed from other respondents whose commitments to CCS were insofar as it served to increase production from oil wells (I23), or insofar as it enabled a continued expansion of oil sands in the province (I27). Another example provides a clear demonstration that a *declaration* of enthusiastic proponency is less an objective position than a strategic position liable to change as the interests that brought the actor to support CCS in the first place shift. During an interview with a senior Alberta public servant, I asked about the government's commitment to CCS:

> EK: *Maybe it's pointed, but how committed is the Ministry to continuing on the CCS path?*

[149] For example, Meadowcroft and Langhelle indicate that motivation to pursue CCS is based partially off of "a need (or a desire) to continue exploiting fossil fuels" (2010: 287). A recognition of a *need* to continue burning fossil fuels, given technological and infrastructural turnover times, differs quite substantially from a *desire* to continue such practices.

Respondent: *More than 150%. More than 150%. So I mean, this [Redford] government, and the previous [Stelmach] government, … I think they get how important it is. So, we've looked at… "Where do our economic opportunities come from as a province, going forward?" And you begin overlay that – and you quickly say, "Ok, we have a huge issue with our industrial emissions... the only way to reduce our emissions in – and get them in line with meaningful reductions is CCS" … There is no other way to do it… so we're committed to CCS… There will be no blinking… It's the backbone of our climate change strategy. No doubt about it.*

However, this "150% commitment" from the provincial bureaucracy relayed to me in September 2012 contrasts sharply with what became a successive distanciation, then rejection of CCS from Alberta's Progressive Conservative political leadership that came after Stelmach's departure. A year *prior* to my respondent's expression of commitment, then premier Alison Redford (who had succeeded the Stelmach government that had initiated the first wave of demonstration projects) "let it slip to Alberta journalists" as Thompson (2013) put it, that she thought there were "better initiatives and opportunities" than carbon capture for climate mitigation. When Jim Prentice succeeded Redford as premier in the fall of 2014, he outright rejected CCS as a development pathway, calling it a "science experiment" (Morgan 2014). This leads me to suggest that one ought to see even those actors who strongly support CCS not as 'enthusiastic proponents,' but as reluctant advocates as occupying strategic subjective positions. One respondent echoed my contention that actors in the CCS community are brought to support CCS from a range of motivations:

EK: *Who is the main proponent of CCS? … At the end of the day, is there someone who is really driving it?*

I35: *Well, in a sense there is a lot of players. Each with their own motivations … And so there's … a whole distribution. You could say that there are players in industry who*

regard a carbon constrained future as being inevitable, who regard this and the social license to operate issue as being absolutely essential to their ability to do business going forward, and who regard access to markets as being a heavily determined by their perception in this field... There are other members – and portions of the industry who deny the existence of climate change and … fund Friends of Science. There are members of the industry who are willing to do things … where they think that it's all about message management. They're willing to do anything that improves their profitability immediately… But they not really interested in getting ahead of the curve. And then so in industry, there's a broad spectrum. Even in government there's a spectrum. So, you know, there's the official government position, but then you talk to the different individuals in government, and they basically mirror that same distribution [as industry described above].

And yet, despite a 'spectrum' of normative beliefs and policy ambitions, a 'common sense' about carbon capture - a common epistemic approach to the problems that carbon capture purportedly solves, and the solutions carbon capture offers – emerges, just at the literature in Chapter 2 (Section 2.6.1) would suggest. This is because the idea of carbon capture, through its circulation, amplification, reification and reproduction, helps the discourse take on an enthusiasm for carbon capture than is more than the sum of the parts of the actors who create and circulate it. The result is a sort of strategic 'coalition of the willing.' As Mosse contends, "common narratives or commanding interpretations are supported for different reasons and serve a diversity of perhaps contradictory interests" (2004: 647). Yet, as Hajer's EDA concept would suggest, the presence of a common *narrative* need not imply common *purpose*. Put differently, while storylines might provide "mobilizing metaphors" (Mosse 2004: 663) they do not guarantee troops will win the war, nor do they guarantee that the troops were not conscripted, hired as mercenaries, double agents, or

otherwise. It is the narratives that keep network together. Indeed it is the narratives that constitute the community.

Thus, it is not the stated ends of carbon capture that keep the network together – the deployment and scale-up of carbon capture, but instead an intersection of means. And seeing actors involved in the carbon capture network as reluctant advocates, as strategic subjects, enables us to understand how carbon capture operates as a fix. It is now possible to see that advocating for carbon capture as a fix through the production of knowledge and policy should not be mistaken for desire to achieve carbon capture as physical fact. Instead, I submit that support for carbon capture, in the case of Alberta, can be understood less as a coherent strategy for the successful implementation of the technology by 'enthusiastic proponents,' than as a network of carbon capture allies that work in cooperation to the extent that the pursuit of carbon capture technology enables them to pursue a variety of goals.

As such, the notion of epistemic communities (presented in Chapter 2) can be used to partially account for the 'social life' of carbon capture in Alberta. But in order to account both for the range of normative beliefs and ultimate ambitions amongst actors, I make a case for viewing the groups of allies working for the development of carbon capture in Alberta as a 'network' instead. While community implies common purpose and an (at least somewhat defined) interior and exterior, the idea of a network implies a distributed set of actors and goals that are connected, albeit without a necessarily defined in-group and out-group. The network conception both attunes to the varied commitments of CCS actors, while simultaneously accounting for the fact that moments of knowledge-production and governance are often very closely intertwined.

Our next task is to explore how, while the discursive and policy matrices developed by the carbon capture network might pre-figure what is 'thinkable, sayable and doable' about carbon capture, the ultimate trajectory and fate of carbon capture is also conditioned by both forces

'outside' the network, as well as by forces which the network externalized through omission, disavowal, or lack of due consideration.

6.3 "A Notable Lack of Success": Cancellations and Set-backs in the Deployment of CCS

Discourses outlining the need for CCS or justifying its use have been articulated with the implicit or explicit support of a CCS community that includes major energy industry players (such as Shell, Chevron, BP), supportive national and sub-national governments (like Canada, the US, the UK, Australia, the Netherlands, and Japan), and powerful non-state actors such as the IEA, the IPCC. But the existence of a common set of supportive narratives about a technology, and their use by powerful actors, does not guarantee its success. Nor, it would appear, have numerous regulatory supports, like Alberta's Regulatory Framework Assessment, the IEA Roadmaps and the EU ACCSEPT program (Bäckstrand et al 2011: 277) been enough to get carbon capture technologies beyond limited scale-up. As Bäckstrand et al. (2011: 277) observed, "[a]lthough many developed states have implemented a variety of technological support policies for CCS, to date progress in demonstration and deployment has been modest." In short, the forms of regulatory, legal, and financial support that have been furnished to incubate CCS have not translated into the number and scale of on-the-ground projects proponents had envisioned in their predictions.

This section explores how, despite the uptake and circulation of numerous storylines supporting the need for CCS, and substantial support, the CCS proponent community has made "negligible progress" in scaling up CCS technology over the last decade. First, I discuss this lack of progress around the world, and describe some of the setbacks CCS deployment has encountered internationally. In 6.3.1, I detail respondent's views of why one of the four subsidized Alberta projects, TransAlta's *Project Pioneer*, failed. I note common threads between the particular case and

respondents' views of the biggest challenges to CCS overall, the topic of sub-section 6.3.2. In sub-section 6.3.3, I suggest that the lack of progress can be accounted for, among other things, by multi-scalar climate change policy vacuums. The section points the way to the chapter conclusion, in which I consider the ways in which CCS makes 'thinkable, doable, and sayable' a kind of strategy in which instrumental failure demands new terms of success for CCS.

In the mid-2000s, expectations surrounded carbon capture and storage technology abounded. Markussen, Shackley and Evar described the "great hopes" that had been pinned on the technology, arguing in 2010 that carbon capture "has risen meteorically among climate change mitigation options," noting the "cornerstone" place it had been given in many countries mitigation strategies (2012: 1). Since that time a few notable projects have come online or are under construction. In 2015, the Global CCS Institute reported that there were 13 (but see qualification)[150] large-scale CCS projects in operation, with 9 under construction, which translated into "an increase of 50% since the start of this decade" (Global CCS Institute 2015). The biggest recent success was SaskPower's Boundary Dam coal with CCS plant in Estevan, Saskatchewan that came online in the fall of 2014, considered the world's first large-scale power sector CCS project (McCarthy 2014a). The Shell Quest came on line in the fall of 2015, and the other major CCS project, the Alberta Carbon Trunk Line, is slated to begin operation in 2016 or 2017.

But the last ten years have seen the number of delayed, or all out cancelled projects far outweigh the number of successful projects. A rash of project cancellations and delays has occurred in every major centre of CCS activity, and over the past few years, numerous projects were

[150] The GCCSI's numbers – 13 plants in operation, 9 under construction – however, require qualification, given the specter of enhanced oil recovery and the unanswered questions of the differences in ultimate net carbon sequestration between EOR and "dedicated carbon storage." Of the 13 projects operating, only 3 are designated as dedicated geological storage: BP's In Salah project (2004), and Statoil's Sleipner (1996) and Snøhvit (2008) projects. And of the of nine projects under construction, only the Alberta Shell Quest project and two others (Illinois Industrial Carbon Capture and Storage Project (USA) and Gorgon Carbon Dioxide Injection Project (Australia) are dedicated storage. Although, according to one respondent, even though the Shell Quest project is categorized as a dedicated storage project, after meeting certain demonstration requirements to the province, the company may start diverting some of its CO2 stream to enhanced oil recovery (Interviewee I14).

postponed, or "restructured." [151] Arguably the most notable cancellation was Statoil's CCS project, Test Centre Mongstad, at its Mongstad refinery. When the project was announced in 2006, then Prime Minister Jens Stoltenberg called it Norway's "moon landing," but it was cancelled due to "cost overruns and delays" (Bergman 2013). Even in Australia, the nation that had expended generous political and financial capital to the cause of CCS (see Chapter 5), CCS was experiencing serious claw-backs in government support and funding, such that by 2014, Renew Economy pronounced, "CCS in Australia is in a nosedive" (Burton 2014).

In all, no new, dedicated geological storage projects have come online since 2008. The failure to bring projects online has led to "continual extension of various institution's expected timelines for CCS deployment and CO_2 reductions" (Campanella 2011: 43-44). By 2012, scholars were remarking that, "the future of CO_2 capture and storage now appears to be far more uncertain than just a couple of years ago" (Markusson et al. 2012). By 2014, Stephens had declared that, "widespread CCS deployment remains a distant, far-fetched, extremely expensive possibility" (170). So how might one apprehend the rapid ascendency of this technology in policy circles and climate change debates as a legitimate carbon mitigation option, and the lack of on the ground projects? And how do we account for this disjuncture given that, as Campanella framed it, the "notable lack of success in implementing projects," occurred "despite … significant and influential sources of support for CCS" (2010: 7). Or as Markussen, Shackley and Evar posed the question, "[i]f the technology is back by resource-strong actors, why then does progress seem to be stalling?" (2012: 1).

[151] This includes the Kemper project in Mississipi (cancelled in June 2015), FutureGen project in Illinois, USA, the ZeroGen project in Queensland, Australia, the Killingholme project in the UK, and Vattenfall's Northern Jutland project in Denmark. Many others were cancelled: Vattenfall's project in Germany, Shell's Barendrecht project in the Netherlands, BP's Peterhead project in Scotland, as well as the Halten CO2 project in Norway, the UK Kingsnorth and Longannet projects, and the Kwinana project in Western Australia. BP's CCS project at a commercial hydrogen power plant in Carson, California, first announced in 2006, had 'stood down' by 2007, and by 2009 was quietly abandoned (Campanella 2011: 38).

Scholars and commentators attribute project failure to a confluence of factors, including economic recession, the efficacy of public policy, public acceptance, and the trajectory of international emissions abatement efforts (Bäckstrand et al. 2011). Herzog (2010) listed cost, transportation infrastructure, subsurface uncertainty, regulatory and legal issues as the key issues that would make or break the move of CCS "from megatons to gigatons." Many scholars attribute the set-backs in CCS scale-up to multiple, intersecting forms of uncertainty (von Stechow et al. 2011), which include geophysical uncertainties qua storage capacity and permanence; economic uncertainties, including concerns about high capital and operating costs, and uncertainties about stable financing from industry and governments (Torvanger and Meadowcroft 2011); uncertainties over the inclusion of climate change in the Clean Development Mechanism; long-term liability; as well as uncertainties surrounding 'social acceptability' of the technology (Shackley et al. 2009).

What is clear from the CCS literature is that most of the uncertainties, and reasons for postponements and cancellations of projects, have less to do with the technological and geo-engineering dimensions of CCS than with the social, economic and political contexts in which projects are being planned (Torvanger and Meadowcroft 2011). As such, several scholars in the literature on social dimensions of carbon capture argue the that fate of carbon capture "must be understood in the broader context of uncertainties about the societal response to climate change and the long-term evolution of major socio-technical systems" (Meadowcroft and Langhelle 2010: 287; see also Meadowcroft 2009, Rai et al. 2010). Bäckstrand et al. similarly argue that, "[e]xperience with other novel technologies has shown how profoundly technological trajectories are shaped by societal processes" (2011: 275), echoing a fundamental insight of science studies - that science and the social order are coproduced (Greenhalgh 2008, Jasanoff 2004). This suggests that CCS technology is dependent on the ways actors sustain it through adaptation to constantly changing social terrains, an argument I return to at the close of the chapter. What will become evident in the following sub-section is that, in making determinations about what factors lead to

success or failure of CCS, the categories actors use to describe carbon capture and its problems have a profound influence on development trajectories. From this case, it is possible to see that any clear-cut distinction between technical and non-technical factors for failure is an over-simplification.[152]

6.3.1 Opening Pioneer's Black Box: Why did an Alberta Project Fail?

Canada and Alberta were not immune to the rash of project cancellations seen elsewhere. Referring in 2010 to the Canadian case, Jaccard and Sharp wrote that carbon capture had made "negligible progress over the past decade" (2010: 75). The cancellation of the Pioneer and SwanHills projects in 2012 and 2013, respectively, have added to the sense that Canadian carbon capture was not materializing according to visions laid out in roadmaps and taskforce reports. In this section I detail interview respondents' views on why TransAlta's Pioneer project did not proceed. I do this in order to demonstrate the range of factors that affect carbon capture project success within the Alberta context, and in order to ascertain how the challenges facing this particular project map onto the biggest challenges to carbon capture technology in general.

Table 6.3 provides the reasons given my respondents for why Pioneer failed. The project proponent, TransAlta, also furnished reasons for cancelling the project. After conducting a front-end engineering and design (FEED) study, TransAlta and its industry partners concluded that, "although the technology works and capital costs were in-line with expectations, the market for carbon sales and the price of emissions reductions were insufficient to allow the project to proceed" (TransAlta 2012). Thus, the official reason for cancelling the project was weak prices for carbon on

[152] One example is Norway's Mongstad project. The failure of the project was framed as one of cost overruns. But of course, cost overruns were the result of *technical* complications arising from upgrading an existing plant with CCS during plant operation translated, which in turn were the result of underestimations of the complexity of such an operation. Moving the other direction, cost overruns translated into public acceptance and political legitimacy issues (the head of the pro-CCS Norwegian ENGO Bellona blasted the Stoltenberg government on Mongstad, charging the project amounted to "some of the worst form of incompetence I've seen from the government, … [t]his will stand as the symbol of this government's total failure on climate policy" (Bergman 2013).

two fronts – the price for carbon in the CO_2-EOR market, and the weak compliance costs of emissions reductions (weak costs through provincial SGER regulations, and zero compliance costs at the federal level). Overall, this view accords with, if not oversimplifies, the perspective of others in Alberta's CCS community.

Table 6.3 Respondent views on why TransAlta's Project Pioneer did not proceed.[153]

1. Risk aversion/risk management issues (5)
2. No CO2 for EOR buyer (6)
3. Carbon price too low (3)
4. Weak or non-existent compliance cost (federal) (4)
5. Weak compliance cost (provincial) (2)
6. Project cost too high/economically untenable (3)
7. Fracking/horizontal drilling/low gas prices (2)

The most common answer from respondents was that TransAlta is a risk averse company, or a company with a lower tolerance for uncertainty (reason #1). Three respondents (I34, I36, I39) described that the company's risk aversion was because it is a relatively small company. One respondent attributed risk aversion to the fact that the company is a utility, and would be a 'first mover' in power plant CCS:

> I18: *A couple reasons. Electric utility are known as utilities… because they were in the utility business, because they're government sanctioned monopolies, right?... and so government said we will control you in return for a fixed rate of return. So what this means is that utilities are, to be frank, crap at risk management. So, … if you're gonna do which is a very new technology particularly like CCS …then there's the technology risk of*

[153] Note: the number of respondents to this question was n=12, and many respondents offered multi-causal answers, which are broken down into component parts in this figure (n=25).

being a first mover and building a large power plant with CCS. And so I think when, as a utility, they just didn't know how to manage that risk and that was a really big thing.

Another respondent made links between risk aversion/uncertainty, and two other factors cited by respondents as the reason for scrapping the project: no EOR buyers for CO_2, which translated into lower than expected revenue for $C0_2$ (reason #2), and a provincial carbon price that was too low (reason #3):

I27: *...those are all contributing factors... my electricity sector: they're risk averse... I'm going to give you the wrong numbers, but if Pioneer cost a $1 billion, so TransAlta needs to get up to $1 billion... for them to say "yes" to Pioneer, and Alberta's going to give them 431 [$ million] from [the] grant program... that's what they were notionally allocated to get. They're going to make up $600 million, they were going to realize this through two things. They were going to realize it through EOR revenues... and they were going to realize it on ... the price of carbon...*

One respondent explained how expectation of revenue from EOR (reason #2) (part of TransAlta's business case for the project) related to untenable project costs (reason #6):

EK: *Why did Pioneer not go ahead?*

I7: *... well, part of it was cost. Well, I think it was all cost... And the problem is they were counting on EOR... they were hoping to get long-term EOR contracts for their CO_2. And... it's highly unlikely that any oil and gas operator will ever commit to a long-term contract for CO_2.*

Another respondent explained this in terms of the divergent timelines and discrepancies between TransAlta's need for steady supply of carbon dioxide, and EOR operator's need for variable demand:

I27: *Are you familiar with the term off-take agreement?*

EK: *No.*

I27: *I produce CO_2, and you're .... an EOR potential ... client of mine. I want you to sign an off-take agreement with me, guaranteeing me you will take my CO_2 volumes. So that means two things. It means that if I'm producing a megaton a year, you will take a megaton a year, because I don't want to get screwed and put it in the atmosphere and pay Alberta 15 bucks a ton. [...] So as part of your off-take agreement, I also need you to guarantee a long time frame. Twenty years, ... Because it's a billion dollar play with $40 million a year operating expense... you can't say "I'll sign a two year agreement with you." That doesn't mean no good. So the length of time, and the volume of CO_2 causes the EOR community issues, because EOR just views CO_2 as a commodity that is one cost into making a business decision. So why would I sign a 25 year agreement with you at a fixed price when the price of CO_2 might go down in 3 years? ... So you've got the time, price of CO_2, and the volumes to be problematic. So [an] EOR [operator] says "We can predict how a formation will respond to injecting CO_2, but we're not always right." So what happens if I only need half a million tons a year, and I don't want your other half a million tons a year? ... Right. Who, who now owns the liability with venting half a million tons a year?*

A lack of EOR buyers for CO_2 (reason #2) is also related to reason #7 for the failure of Pioneer, the role of new fracking and horizontal drilling practices, and subsequent low gas prices (caused by fracking-induced supply glut). The connections between the 'revolution' in fracking and horizontal drilling practices that were talking off in the late 2000s is articulated by I27 who explains how that these practices were disruptive to the business case for CO_2-EOR:

I27: *...and then the other challenge for EOR ... well the last five years, we've all been stunned to see fracking mature. And we've been stunned to see how quickly directional drilling has changed how you recover resources...This technology's taken off. Lots of people are fracking formations to ... make the oil easier to access, and I don't have to deal with all this crazy CO_2 stuff... as an investor, ...it's a better rate of return [...] We didn't see – the technology... we didn't appreciate fracking as an opportunity. It took off; it's everywhere. None of us were prepared for it, but it's here... It will defer CO_2 flooding for EOR purposes, I think. Certainly in Alberta.*

One can also see that both the lack EOR buyers for carbon dioxide and a provincial carbon price that was too low are themselves related in the following respondent's view. They suggest that the Pioneer project would have flooded the market, reducing the provincial price on carbon (nominally $15 as in the SGER regulations) even lower:

I16: *Pioneer – it was pretty clear a couple of things – One: the market for C02 – so they had always planned to be able to sell their CO_2 for enhanced oil recovery. I think one of the errors that the Alberta government made in ... thinking about the funding needed for these projects is that they took the CO_2 price as kind of a given. Like, "OK, how much does CO_2 sell for on the market?" – "It sells for $20 a ton," or whatever. So – "OK, that's what we'll put in our revenue models when we see how much these projects get to sell their CO_2 for." But ...the CO_2 market for EOR was this tiny little sliver of the market and now you're going to come in with 4 million tons a year of... government backed CO_2 and flood that market. So what happens to the price? The price goes through the floor [...] And so I think that's most of what happened at Pioneer.*

And, of course, as I16's response indicates, and I will elaborate upon in sub-section 6.3.3, reasons #3 (carbon price too low) and #6 (project cost too high) are themselves intricately linked

to reasons #4 (weak or non-existent federal compliance costs) and #5 (weak provincial compliance costs) for the failure of Pioneer:

> I3: *and the other thing with TransAlta... I've heard them say that really, the cost of CO_2 um... on the regulatory side of it, isn't high enough. The compliance costs aren't great enough. And that's not just from the province, but also from the feds. The feds don't have penalties for emitting CO_2...*

Several other respondents indicated that a lack of federal policy on carbon emissions had a detrimental impact on the outcome of Pioneer. As I16 explains below, when TransAlta had made its initial bid in 2010 to receive the CCS subsidy, it was operating with the expectation of forthcoming regulations stemming from the federal government's 2007/2008 *Turning the Corner* policy under a Stephen Harper minority government.[154] However, the plan was "quietly dumped" (Partington 2013), and the Harper government, instead of pursuing a climate change policy *per se*, opted for sector-by-sector emissions regulations, starting first with an emissions performance standard for coal-fired power, which came into effect in September 2012[155] (Government of Canada 2012).

Along with I3, several other respondents spoke about the impact of replacing a carbon pricing policy with an emissions performance standard:

> I18: *I think that the genesis of project* Pioneer *was probably around in that time period [when] the federal government walked away from that and went to the emissions*

[154] The plan would have required significant reductions in emissions intensity, including heavy and hydrocarbon industries, and implementation would set Canada on a track for meeting Kyoto commitments (Partington 2013). As the Pembina Institute argued, "[t]his wasn't some back-of-the-napkin concept, but rather a full-scale plan aggressively marketed in Canada and touted at international meetings," one which was expected to reduce project oil sands emissions by 55 percent (Partington 2013).

[155] By 2015, oil and gas regulations, which were supposed to be released in 2011 have still not been enacted, despite multiple delays. In late 2014, Prime Minister Stephen Harper said it would be "crazy" to introduce regulations in the context of a major global oil price slump (McDiarmid 2014). The coal sector regulations are considered weaker than *Turning the Corner* proposals (Partington 2012), and are based on a performance standard (instead of flexible compliance mechanisms) of 420 metric tons of carbon dioxide per gigawatt hour. Equivalent to high-efficiency natural gas-fired or renewable generators, the regulations essentially make the construction of a new coal plant impossible with CCS. However, the regulations do not come into effect until July 2015, and as the Pembina Institute argued in a press statement, "[m]ajor changes to the draft rules will allow the oldest and dirtiest coal plants in Canada to run for up to half of a century from commissioning without any limits to their climate pollution" (Jones 2012).

performance standard, and then ...TransAlta saw no value in monetizing the emissions reductions below that standard.

The Pioneer case offers one example of the failure of a CCS project. While not representative of all possible project cancellations internationally, it does shed light on some of the key barriers to carbon capture scale-up in the Canadian context, and allows me to draw out three important points. First, it shows that 'cost,' normally conceived as a strictly 'economic' category, as a barrier to CCS, must be considered in relation to state policies and regulations (explored in the following subsection). Second, it demonstrates that many CCS actors in Alberta were operating in the expectation of the introduction of stronger carbon pricing system (which I discuss in terms of a policy vacuum in sub-section 6.3.3). Third, it raises the specter of the 'reluctant advocate,' by showing that if CCS is indeed operating as a techno-fix for a contingent alliance of actors vested in Alberta's fossil fuel economy, the discrepancy between the expected conditions of their support for the fix, and the actual conditions (presented as barriers or challenges) reveals the paucity of 'true believers' in CCS.

6.3.2 Carbon Constraints and Biggest Challenges: Cost, Policy or Policy = Cost?

The case of Pioneer shows that 'cost' as a barrier to CCS must be considered in relation to state policies and regulations. This section uses respondents' views about the biggest challenges to suggest that 'cost' barrier arguments are less purely 'economic' questions than questions of state regulations. Both CO_2 markets for EOR and avoided compliance costs in a regulatory regime demonstrate the critical role states play in not just regulating market forces, but also making markets.

In addition to asking for their views on why project Pioneer was cancelled, I also asked eighteen of my interviewees for their views as to what was the biggest challenge to the scale-up of

carbon capture in general. Table 6.4 lists the variety of responses received. I arranged the responses into six different categories, but the first three - capture cost, price of carbon too low, gap between price of CO_2 and cost of CCS – were all 'economic' reasons. The most common responses were that cost was the biggest barrier to CCS (7), or that cost in relation to price of carbon is the biggest barrier (2+1) (7+2+1 = 10). But many respondents indicated that the biggest barrier was a policy or regulatory gap or vacuum (5). Furthermore, for many respondents, the two issues were connected: they saw cost as the largest barrier to CCS *as a result of* policy/regulatory gap/vacuum (7). In all, twelve (5+7) respondents saw a policy/regulatory gap/vacuum as the *first order* largest barrier to the advancement of CCS technology.

The relation of cost to policy and regulation requires me to make a brief detour to unpack the issue of the "cost," and to elaborate, using the concept of Marginal Abatement Cost (MAC), that what constitutes cost is variable. Economists call the cost of reducing pollution (negative environmental externalities) an abatement cost. "Marginal cost" refers to the cost of an additional unit of something (e.g., the marginal cost of production of oil would be the cost of producing one more barrel). Thus, marginal abatement cost (MAC) measures the cost of reducing one more unit of pollution (Climate Works Australia 2013; Ekins, Kesicki, and Smith 2011). The general consensus among economists is that for a given firm (or equivalent actor), the lowest cost abatement option will be selected first, so that initial pollution abatement can be obtained for relatively cheap (Ekins, Kesicki, and Smith 2011). However, moving towards 100 percent abatement gets increasingly expensive, and as such, marginal abatement costs increase as more pollution is abated.

Economists have developed marginal abatement cost curves (MACCs) to compare the relative costs of different pollution abatement options. MACCs "have frequently been used to illustrate the economic and technology feasibility of climate change mitigation" (*ibid.*), by ordering different mitigation options from cheapest to most expensive (swapping out lighting for LEDs, to

reduced pastureland conversion, to CCS plant retrofits), with cost bands associated with each option.

For our purposes MACCs demonstrate two things. First of all, they underscore the fact that when actors consider the cost of mitigating climate change, they will inherently consider the cost of CCS in relation to other options on the curve. Cost is, therefore, relational. Secondly, the estimated cost bands for CCS vary considerably (Nelder 2013). For instance, a 2011 estimate by the Global CCS Institute put the cost of CCS between US$23-92 per tonne of CO2 (Abellera and Short 2011), a large band of uncertainty. Other studies provide radically different cost estimates (Rubin 2012). The reason for such high cost uncertainty is due to the simple fact that there are so few actual projects in operation, and so many unique design considerations for each project, and thus a small, but highly variable pool of data from which to generate estimates. Rubin (2012) attributes the "confusion, misunderstanding and possible misrepresentation of CCS costs" to cost methodologies and "significant differences and inconsistencies across different studies."

Table 6.4 Interviewee views biggest challenge to CCS.[156]

1a. Cost (7)
1b. Price of carbon too low (3)
1c. Gap between price of CO2 and cost of CCS (1)
2. Policy/regulatory gap/vacuum (5)
3. Cost *as a result of* policy/regulatory gap/vacuum (7)
4. Public perception/acceptance (3)

Several respondents indicated that cost was the biggest barrier to CCS, for example:

[156] The number of respondents to this question was n=18. Note: many respondents offered multi-causal answers, which are broken down into component parts in this figure.

I26: *What's the biggest challenge to CCS? The cost…and I think that's the challenge both locally and internationally. The gap between the price of carbon on the market and the actual cost of injecting a tonne of CO_2 …*

…

I27: *Yes, cost of capture. Cost of capture is the only challenge facing CCS…*

However, others indicated that while cost was the biggest barrier to CCS, it acts as a barrier *in relation to* the price of carbon:

I36: *For the future of CCS… it will depend on what happens with the price of carbon. So if it becomes economically viable to … capture and store …CO_2 in subsurface, then more projects, will be developed because it would be an economic driver…*

And the price of carbon as a barrier manifests in the same two ways seen above with Pioneer – either a) in terms of the price of carbon sold for EOR:

I7: *The single biggest has got to be economics. [Because] it costs a heck of a lot of money, and until we have a higher carbon price … there's no revenue stream unless you're doing EOR. And I suspect…some people talk about "CCS isn't gonna happen without EOR." But I suspect that even EOR's not going to be the savior people hope for. And in Alberta we're a long way from the time when oil and gas producers will really want to do a lot of EOR. […] So we need the costs of capture to go down, and the price of carbon to go up… both significantly.*

Or b) in terms of costs consisting of compliance costs, which put an effective price on carbon:

EK: *What, in your view, is the biggest challenges to CCS?*

I43: *Well, definitely it's cost. But, you know, cost is a combination of a lot of things. Cost includes the cost of compliance for greenhouse gases… no one's going to do this because they think it's a nice thing to strap on to their facilities… CCS technology they're doing because their forced to manage their greenhouse gas emissions. So that's because there's a regulatory framework… And in Alberta we have a little bit of that. We've got greenhouse targets, and we've got a $15 per ton charge. But that's nowhere close enough to be able to make a business case for CCS.*

Thus, considerations of the "cost" of carbon capture are not just cost of capture, but also compliance costs. And while the Alberta provincial government does imposes compliance costs on big emitters – the Specified Gas Emitters Regulation $15/ton charge, this is insufficient for a "business case" for CCS. As such, many respondents viewed cost as a second-order obstacle caused by a first-order barrier: the absence of sufficient government regulation that would incent or make mandatory the internalization of the cost of polluting into the cost of business. One respondent offered a view that demonstrates the connection between 'technological,' 'economic' and 'regulatory' barriers to CCS:

I8: *CCS doesn't produce anything, therefore, you cannot make money out of it. It is a cost. And as such … the technological challenge is to bring to cost down. Particularly the cost of capture… So there is research going on capture to try to bring down the cost. But assuming that cost would be a non-issue or cost would be covered through a carbon tax or similar mechanism, then the technology can be applied today. …Nevertheless it cannot be applied today because there is no policy, legal and regulatory framework in place to apply CCS, OK?*

For I8, not only the are economic dimensions of CCS highly essentially subsets of its political and regulatory dimensions of carbon capture, CCS researchers acknowledge that many of the so-

called 'technological' barriers for CCS are actually "techno-*economic*" problems (Koelbl et al. 2014). For instance, within the scholarly literature on CCS, Koelbl et al. 2014 identified power plant efficiency and investment *cost*, capture *cost*, transport *cost* and storage capacity as the biggest "technological key parameters" influencing the scale of CCS deployment.

Thus, while some articulated the biggest barrier in terms of a twinned second- and first-order argument (cost because of lack of regulation), others simply provided the view that the first-order problem – a lack of, or insufficient level, of government regulation. One respondent in particular tied the first-order problem to an even broader level argument – the lack of social value placed on climate policies (an issue I return to in the conclusion when re-evaluating CCS as a response to democratic pressures for climate change mitigation):

EK: *What is the single biggest single challenge to CCS?*

I31: *Yah – there's no climate policy …the only reason is we're doing CCS is to reduce CO_2 from the atmosphere. Right? It's an added cost across the board. So I'm sure most people say the cost of capture. But regardless of if it's high or low, its still an added cost, right? And so if society is not valuing reducing CO_2 from the atmosphere, then there's no need to do CCS. … And so if society's not valuing that, … then there's no need to do it. And so we still do not have a federal climate policy in Canada, so there you go. There's the number one challenge […] it comes down to the actual demand for having CO_2 out of the atmosphere. And we don't – in my mind – we don't have that.*

But a federal climate policy in Canada is exactly what CCS proponents and advocates were expecting. Many CCS actors in Alberta, not just TransAlta, but also other industry players, provincial government decision-makers, were operating in the expectation of the introduction of stronger carbon pricing system, both through international channels and federal regulation. In 2012, Canadian Business reported that "[t]wo expectations underpinned Alberta's approach" to carbon

capture – decreasing per-unit costs on CCS from experience 'learning curves,' and expectation "that new regulations would introduce per-tonne costs for emitting CO_2" (McLearn 2012). In 2009, the Alberta Carbon Capture and Development Council's Final Report argued that CCS would be "the key to the continued development of our vast energy resources in the carbon-constrained future we face"[157] (2009: 7). The Council argued that it would be "difficult to predict" future costs of carbon constraints (*ibid.,* 11), but nonetheless used a $30/tonne avoided cost of compliance in the 'Hypothetical Economic Profile' used to make its "Business Case for CCS" (*ibid.,* 37-39), an avoided cost of compliance twice rate of the SGER.

The expectation of a 'carbon constrained future' with higher carbon prices was a consensus assumption in the 'business case' for CCS for Alberta actors. However, the four Alberta CCS project proponents – TransAlta, Enhance Energy, Shell and SwanHills Synfuels – were differentially able to navigate the effects of the post-2009 carbon *un*constrained world. In February 2013, after I finished the majority of my fieldwork, the SwanHills Synfuels CCS project was also cancelled.[158]

The brief investigation of the challenges to Alberta carbon capture projects in the last two sub-sections underscores a few details that help paint a complete picture of how and why carbon

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[157] The "carbon constrained future/world" can itself be considered a storyline: it is a narrative that condenses a range of expectations about future conditions in which the use of carbon will be restricted. Although 'constraint' may arise from any number of factors - through regulatory restrictions, carbon pricing, lower-carbon development pathways, political pressure or sheer biophysical necessity – it is typically used to infer that constraint will come from mandated restrictions on emissions. It is used by media, think tanks, NGOs, financial and energy industries, and within scholarly literature (in particular energy policy and engineering journals). But the anticipated climate future of a carbon constrained world fell apart at the December 2009 COP-15 talks in Copenhagen (see below).

[158] Since most of my fieldwork had been completed, I was not able to garner a similar set of respondents from interviewees about the SwanHills project cancellation, but I was able to get the perspective from one of two interviewees I met with after the SwanHills cancellation announcement. In this respondent's view, the SwanHills case was different in some respects from the TransAlta case – the company was smaller, had little experience with big projects, and even less tolerance for project risk, but they still indicated that the project failed because of cost decisions. The respondent offeredg insight into how Shell's Quest project and the Alberta Carbon Trunk might have been able to succeed despite the cost and policy/regulatory vacuum challenges. In this respondent's view, because Shell is a major IOC, any benefits from the project (process learning and innovation) can be applied to other parts of its operation, and it was can lose money on Quest since a $1 billion project is a relatively smaller share of their operations. Furthermore, s/he echoed what another respondent said off record that Shell could effectively put any money expended on the Quest project into its yearly advertising budget. They also suggested how they thought Enhance Energy was able to succeed amidst cost and vacuum barriers because of Enhance Energy's complex integration of projects surrounding its carbon capture project. It combines a refinery, a CO_2 pipeline, EOR and a fertilizer plant within one operation. Unlike TransAlta, whose carbon capture project depended on finding an EOR buyer for its CO_2, Enhance would essentially use CO_2 it captured in its own refinery and fertilizer plant to then use for CO2-EOR in its own oil wells, eliminating the need to find a CO_2 buyer.

capture projects in Alberta have both succeeded and failed, and with what effects. First, the diversity of outcomes for the four Alberta carbon capture projects reveals that there is no monolithic industry approach to carbon capture. Narita (2010) and Tjernshaugen (2008) have both articulated the diversity of fossil fuel industry engagement with carbon capture, relating degree of involvement with the degree to which the company publicly acknowledges the necessity of actions against climate change.[159]

A second notable detail, however, does underscore one monolithic certainty shared across industry – that it will not voluntarily enact environmental mitigation measures that risk profit loss. Thus, in light of carbon capture being a "very expensive process" (I36), projects are feasible only in the context of sufficient regulatory support. This is something most respondents seemed to understand, and that both the EETF and the ACCSDC made clear in their 'business cases' for CCS. As the Alberta Carbon Capture and Storage Development Council framed it, there is "a strong desire" within the Alberta fossil polity "to maximize the use of this environmental opportunity," but only "within the context of maintaining Alberta's competitive advantage" (Alberta Carbon Capture and Storage Development Council 2009: 37).

The third notable detail contributes to our understanding of carbon capture through a governmentality lens, offering a chance to nuance the view of the 'regulatory' dimensions of carbon capture used thus far. Thus far I have discussed regulatory dimensions of carbon capture in the context of what proponents call 'regulatory support' or 'regulatory clarity' (EETF 2008), which refers to issues like applications and permitting, site selection, operation, long-term liability and so forth – the sorts of regulatory issues that were the focus of the world-leading Regulatory

[159] In a study of Canadian oil and gas companies, Woynillowicz (2006) found that, out of a number of factors - including fiscal characteristics and performance, carbon intensity of current production and future reserves, and greenhouse gas emissions performance - whether a company was relatively reactive or proactive with respect to climate change was most strongly influenced by leadership of the company, in particular, the personal views of the CEO. For instance, BP was the first IOC to publically recognize anthropogenic climate change, and was the first company after Statoil to construct a dedicated storage carbon capture facility after Statoil (Narita 2010: 7, Campanella 2011). Sleipner, built in 1997, is a joint venture between majority owned by Statoil, with ExxonMobil E&P Norway and Total E&P Norge, while In Salah (2004) is a joint venture, owned by BP, Sonatrach and Statoil.

Framework Assessment. But as one can see from respondents perspectives on challenges to carbon capture, regulatory support also refers to government mandated emissions reductions (whether inflexible mechanisms like standards or prohibitions, or flexible mechanisms, like carbon taxes or cap and trade schemes). Herein one finds an interesting feature of the 'forms of visibility' that allies in the carbon capture network brought to bear on the development of carbon capture. On the one hand, the consensus 'business case' for carbon capture *assumed* a forthcoming regulatory environment in which emissions reduction regulations would be put in place (federal level) or strengthened (provincial). Yet, proponents avoided actually *advocating* emissions regulations as a means to achieve the business case for CCS.[160]

How does one account, on the one hand, for carbon capture proponents making their business case for CCS based on models that assume compliance costs and/or regulatory requirements, and on the other hand, failure to actually advocate for these costs/requirements? For some development scholars the answer lies in the process of technicalization (Scott 1998, Mitchell 2002, Mosse 2004, Li 2007). Technicalization that inheres in processes of governmentalization (see Chapter 2, Section 2.2) can bring about not only 'forms of visibility' but also forms of *in*visibility, some strategic or intentional.

In the case of carbon capture in Alberta, both unintentional and intentional visibilities operate through carbon capture as a political technology. Some excluded or misrecognized elements of carbon capture and storage's development trajectory could not have been predicted by advocates, such as the take-off in hydraulic fracturing technology that made natural gas cheaper than coal, or the 2008-09 global financial crisis. However, other factors – like the ascendency of wind and solar (Section 6.4.1), organized resistance to projects, and the need for government mandated emissions reductions – could have had a less destabilizing effect on CCS if they had fallen

[160] For instance in the ACCSDC 'Business Case for CCS,' the proposed options for closing the 'funding gap' for CCS were government investment through direct subsidies and capital grants, cost recovery through CO2-EOR, tax and royalty breaks, and double crediting under the SGER (Leach 2012, ACCSDC 2008: 38, 45-48).

within the calculus used by actors to legitimate the technology. For scholars like Li, to the extent that development projects and the political technologies that help constitute them exclude or discount aspects of reality, such projects are more liable to produce unintended effects. The result is that improvement schemes and development projects suffer from the "inevitable gap between what is attempted and what is accomplished" (Li 2007: 21).

I suggested, however, that in some cases, invisibilities in development projects may be intentional or strategic. Was, within the 'common sense' view used by most CCS actors, the double move of making a business case for CCS based on models that assume compliance costs and/or regulatory requirements, yet failing to actually advocate for such costs/requirements, intentional or strategic? Making a definitive claim would be difficult. But it can be said that all actors and communities operate with structured ways of seeing the world, which include the ways in which different parts of the social sphere are delineated and articulated. These structured ways of seeing, I argue, help create make particular invisibilities with respect to carbon capture. The common sense view of carbon capture in Alberta is represented in the work of the Alberta Carbon Capture and Storage Development Council (ACCSDC). In describing it's "Guiding Principles to Advance Widespread Adoption of CCS," the Council recommended that Alberta guide the development of carbon capture within the province a "[m]arket-based approach where possible" (2008: 44). The Council submitted that,

> "[i]ncenting the development of CCS in Alberta could be done with greater or lesser degrees of direct government intervention including roles such as market maker, infrastructure owner, project approver and auditor…. [but w]here possible, using market-based mechanisms to enable private sector players to bring their ingenuity to the task of CCS may lead to the greatest long-run benefits" (*ibid.*).

The Council explicitly advocated for "market based mechanisms" over and above approaches it labeled as "government intervention." Yet, as broadly understood within institutional economics and related disciplines, even 'free market' forces require the legal furnishings of the state to operate (Polanyi 1944). It would appear that the common sense view of the Council operates within a neoliberal worldview that sees the operation of market mechanisms and government action as antithetical. In such a conception of the social world, it is possible to model a business case for carbon capture based on models that assume compliance costs and/or regulatory requirements, but actually advocating for such costs/requirements would be construed as advocated for increased government 'intervention.'

The question then becomes: are the particular arrangements of economic, society and government characteristic of the neoliberal worldview 'misrecognized,' *strategically* excluded or both? One technology writer in 2008 suggested that, "CCS can only be a viable option for reducing emissions if governments offer financial incentives for companies to pursue it," adding that if governments took a "toe-in-the-water approach" to carbon capture, the window of opportunity for the technology might be missed entirely (Sherer 2008). For some of those 'reluctant advocates' allied into the carbon capture network, it is possible to both actively working to develop carbon capture technology, and to work to miss the opportunity for its development entirely at once. The following sub-section gives one example of how the Canadian federal government – a key player in the development of carbon capture - seems to do just that.

6.3.3 No Policy as a Policy? CCS in the Policy Vacuum

As I have shown, TransAlta and other industry players and decision-makers working to advance carbon capture in the 2010s were operating in an uncertain policy environment, but were generally holding the expectation of the introduction of a 'carbon constrained future,' a stronger

carbon pricing system and/or the introduction of emissions restrictions from federal policy. Instead, the period since the institutionalization of CCS has seen a growing policy vacuum at the international and federal level.

At the international level, there is common acceptance that international cooperative climate negotiations have "stagnated" (Bäckstrand et al. 2011: 278) and that multilateral inter-state negotiations have under the UNFCC have failed (Abbott 2014). For many, the 15th UNFCC Conference of Parties (COP-15) in Copenhagen in December 2009 represented a "legitimacy crisis for international climate diplomacy," because of a failure to bring about a climactically appropriate agreement (Abbott 2014, Dellinger 2014) or to establish a new universal legally post-2012 binding agreement after the Kyoto Protocol (Bäckstrand 2011, Grubb 2010). Several commentators have argued that the 2008 global economic crisis was bad timing for the climate, and played a role in derailing climate negotiations as governments saw the optics of setting binding emissions targets in the wake of the crisis as politically unsavvy (Klein 2014). In any case, the current geopolitics of climate change mitigation, therefore, exist as a vacuum for any states who have not made binding commitments in alternative fora.[161]

Canada has played an outsized part in helping to stall forward movement on international climate agreements. As we saw in Chapter 3, when the country formally withdrew from the Kyoto protocol under the Conservative Party of Canada government majority, the country was given the dubious distinction of being a climate laggard.[162] In a 2013 survey index, ENGO umbrella group Climate Action Network International rated Canada ranked 58th out of 61 countries surveyed for climate change mitigation (trailed by Kazakhstan, Iran and Saudi Arabia) (Climate Action Network/Germanwatch 2013).

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[161] Some scholars have argued that the decline of climate multilateralism has been replaced by a " a new multi-polar climate order," oriented towards "G-2" US–China agreements with non-transparent bargaining process, such as President Barack Obama's quasi-backroom Copenhagen accord, and voluntary 'pledges' replacing mandatory emissions cuts and timetables (Bäckstrand 2011).

[162] George Monbiot went as far as to say that, "The Urgent Threat to World Peace is … Canada" (2009) and broke a self-imposed flying ban to tell its citizens just that.

In one sense the federal policy vacuum is the result of the international policy vacuum; the lack of international pressure disincentivizes individual nation-states to undertake reductions of greenhouse gas emissions within their borders. However, this does not account for the large number of countries who are implementing national climate change policies in the face of the international vacuum. Instead, most commentators ascribe the Canadian federal climate change policy vacuum to the ideological perspective and political commitments of the Conservative Party, which has governed since 2006. The government is steadfastly pro-fossil fuel and pro-oil sands development, and has yet to impose sector regulations on the oil sands. The government's consistent message on climate change has been that any regulatory action will be matched US action (McCarthy 2015). However, in late 2014, US President Barack Obama and Chinese President Xi Jinping signed a landmark, aggressive bilateral agreement on climate change. David McLaughlin, former president of the National Roundtable on the Environment and Economy (NRTEE),[163] articulated a new conundrum for Canadian Prime Minister Harper's policy vacuum rationale: "All of our political and policy framework has been around keeping pace with the Americans, and that was fine when the American ambition was modest …But alignment with the US just got a lot tougher and more complex" (in McCarthy 2014a). For Simon Dalby, Harper's stance on climate change makes Canada "look increasingly isolated" (in Chung 2014b), not just from the international community, but also from the provinces in the Canadian federation.

One could view the Conservative Party of Canada, and its leader, PM Stephen Harper's, approach to climate change as constituting a 'policy vacuum.' But some critical policy scholars have suggested that the lack of a policy on a given issue, it *itself a policy.* Kuus describes how policies, "sometimes appear to happen via inaction and non-decision without being consciously deliberated

[163] An independent policy advisory agency to the Government of Canada, made up of business, government, ENGO and other members, and widely hailed as a successful mode of cross-sectoral cooperation on a broad range of environmental issues, the NRTEE was founded in 1988, and operated until March 31, 2013, when the Conservative Party of Canada terminated its funding.

at all" (Kuus 2014: 40). For Page, it "is quite possible that unconscious (or at least unremarked on) inaction is a form of policy making" (2006: 220), citing Bachrach and Baratz's formulation of such a situation as the "non-decision" (1962; see also Shore, Wright and Peró 2011: 11).[164]

6.4 Failing Forward, or Just Failing? On CCS as a Climate Crisis 'Fix'

This chapter has served to demonstrate how discourse and scientific narratives become key policy components, which in turn form a necessary part of how CCS is able to serve as a political technology enabling actors to manage the complex problems of climate change. In order to understand how CCS is advanced as climate change mitigation option, I showed how it first became embedded within scientific and policy narratives, interfacing "particular social and cultural worlds or 'domains of meaning'" (Shore, Wright and Peró 2011: 1). I detailed storylines employed by actors in the CCS network that position CCS as a desirable, legitimate, even necessary development pathway. I also explored the relationship between the production of scientific and technical storylines and the policy/political realm, in the process refining what is meant by the claim that CCS operates as a political technology. Lastly, I showed how, at the current historical conjuncture, CCS faces serious barriers to wide-scale deployment, and that the discursive frame used by many actors plays a role in misrecognizing both the social need for CCS and the role of government regulation in bringing about the scale of CCS deployment that advocates projected.

In this final section, I draw together these findings to complete an analysis of the role that discourse and policy discourse play in the analytics of government into which CCS technology has been imbricated in Alberta. Having explored the links between: a) domains of expertise and knowledge (science, policy, and science-policy), b) the types of knowledge and capacity (power) they produce, c) their relation to the larger political economic landscape, the final task is to assess

[164] For Page, the "classic case" of inaction as policy is here is Crenson's 1971 account of Gary, Indiana, *The Un-Politics of Air Pollution,* where pollution legislation was not introduced despite the high levels of air pollution. That case has many analogies to the case of regulating GHGs in Canada.

what it they accomplish. This proceeds in two steps. In sub-section 6.4,1, I compare energy future scenarios to actual deployment rates for renewable energy technologies. The comparison enables me to make the argument that energy scenarios form a crucial part of the discursive dimension of CCS as a technological fix. They can be read as political strategies and claims on the future. But it also serves to demonstrate that an analytics of government based on narrow epistemic ground and forms of visibility is liable to misrecognize factors that can influence its objects of government, hindering the successful translation of scenarios, plans and policies into physical fixes.

Finally, in sub-section 6.4.2, I will argue that the setbacks and failures of CCS seen in previous section forces a new definition of the terms of success for CCS. I show that since CCS has been advocated by communities primarily as a fix to overlapping crises, the 'success' of CCS policies need to be assessed not in terms of whether CO_2 is successfully sequestered, but instead whether carbon capture successfully temporarily reconciles competing the policy demands that necessitated the fix. Understanding CCS on the merits of its actual effects points me back to the community, the allies – the actors whom strategically support the technology. I suggest that the potential success of CCS is limited by the fact that most of its advocates promote it as a second-order goal, which in the face of changes to the socio-technological landscape in the last ten years, represents a level of advocacy insufficient to bring about the materialization of the technology is a sufficiently meaningful way.

6.4.1 What Modeling Renewables Tells us About CCS

Recent findings regarding energy future scenarios and renewable energy technologies contribute to our understanding of why discourse matters when considering the material outcomes of policies and decisions about energy pathways. In the past two years, numerous reports and commentators have shown that major actors within the energy field, like governments, IOCs and institutional bodies like the IEA, have grossly underestimated the growth of renewable energy,

particular wind and solar. A 2014 report by the Global Commission on the Economy and Climate, found that "[r]enewable energy sources have emerged with stunning and unexpected speed as large-scale, and increasingly economically viable, alternatives to fossil fuels" (2014: 37), and it appears that many of the world energy watchers did not see it coming.

Whitmore analyzed the IEA's 2013, 2014 and 2015 World Energy Outlooks (WEO) and found that the organization's central projections on renewables were "much too low," representing a "continuing a history of vastly underestimating renewables growth" (2015a, see also 2015b). Whitmore concluded that the IEA's Scenarios "do not form a reliable basis for assessing the future of the world's power generation mix" (2015a). In early 2015, the Meister Consultants group released a report, "Renewable Energy Revolution" that supported Whitmore's claims. The report showed that it and many other organizations, like the US Energy Information Administration (EIA) and even the Global Wind Energy Council had "underestimated the scale of actual growth experienced by the wind and solar markets" (Meister Consultants Group 2015). In fact, they'd found that, "[o]nly the most aggressive growth projections, such as Greenpeace's Energy [R]evolution scenarios, have been close to accurate" (Figure 6.2 and 6.3).

So how did it happen that key agencies charged with mapping and predicting the world's energy futures got their figures on renewable energy so drastically wrong? The Global Commission on the Economy and Climate found that, at least in part, the misrecognition of the upsurge in renewables was due to the use of outdated and "longstanding assumptions" (Gillis 2014) on the part of scenario makers. In particular, it was noted that the cost of renewable energy "has been plunging so fast that most previous analyses of its potential role are out of date"(*ibid.*),[165] meaning that energy scenario architects using information that was even slightly out of date would be improperly calculating the per unit costs of these renewable sources.

[165] Clean Energy Canada (2014), for instance, reports that wholesale solar module prices have dropped more than 83 percent from 2008 to 2013, from $4/watt in 2008 to $.69/watt in 2013. Parkinson (2015a) reports figures from the numerous organizations expected a further 40 percent decrease by 2017.

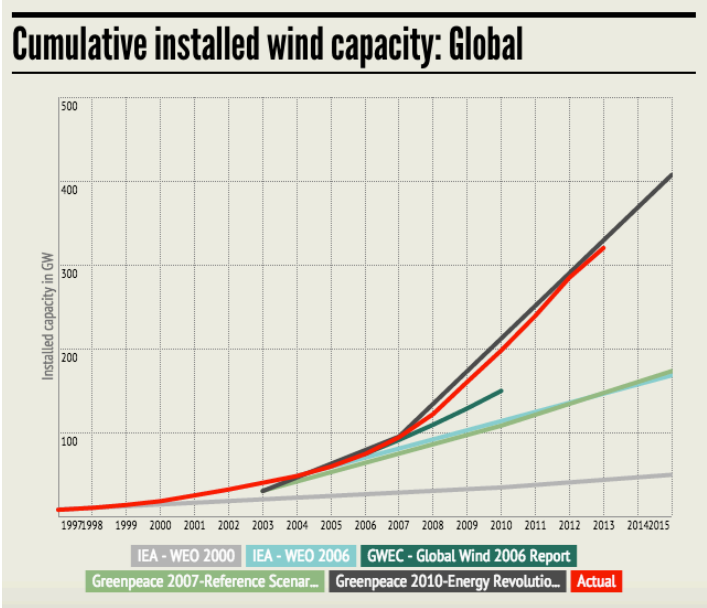

Figure 6.2. Comparative global cumulative installed wind capacity scenarios.[166]

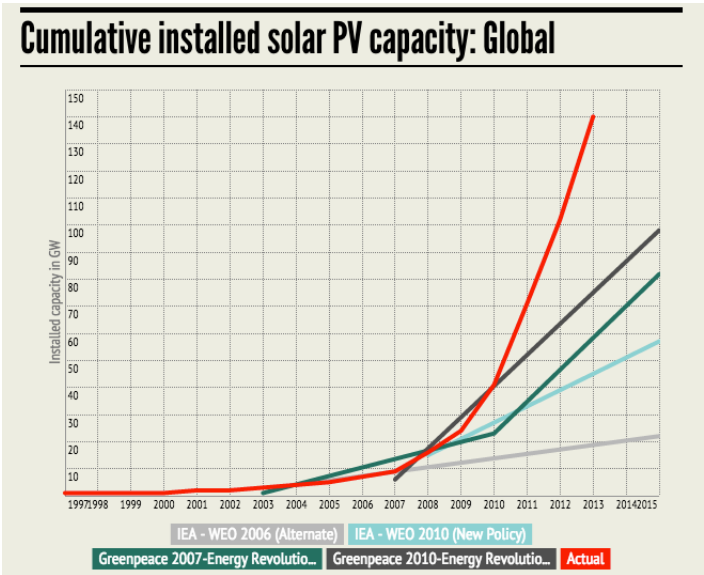

Figure 6.3. Comparative global cumulative installed solar PV capacity scenarios.[167]

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166 Actual versus organization scenarios (International Energy Agency, Global Wind Energy Council, Greenpeace International) (Meister Consultants Group 2015).
167 Actual versus organization scenarios (International Energy Agency, Greenpeace International) (Meister Consultants Group 2015).

In early 2015, Deborah Lawrence, executive director of Energy Policy Forum, offered a reason why energy scenario creators were using out of date assumptions about renewables prices. She suggested that in the U.S. case, players in the energy sector, including governments, are still largely focused on fossil fuel energy and "incessantly fixated on the "shale revolution"" (2015). As a result, they have been blinded from realizing "that renewables had entered the era cost competitiveness" (Lawrence 2015). Indeed, for Ethan Zindler, Head of Policy Analysis at Bloomberg New Energy Finance, 2013 marked the watershed year in which renewable power projects began to reach investment parity, earning clean energy "the right to not be called 'alternative' anymore" (in Dembicki 2014). Just a year later, 2014 marked the first year in history that investment in renewables exceeded investment in fossil fuels (Randall 2015), and the trend is expected to continue.

Seeming to confirm the Commission on the Economy and Climate's contention that many participants in the energy sector were formulating their views of renewables on outdated assumptions, I repeatedly found in my interviewees discounting of the viability of renewable energy as a serious mitigation option. For instance, in arguing that there was no alternative for Alberta but to develop CCS, one argued thusly,

> I7: *Well… if you have a complete change in societal mindset, then you can do without CCS. But we all have to start driving electric cars, and have solar panels on every house… So they figure that one out, then maybe we can move away from coal.*

For this respondent, the rapid scale-up of electric cars and solar panels would entail a "complete change in societal mindset," something they didn't see as possible within any near future. Another respondent dismissed renewables on the grounds of cost:

> I8: *… you have to choose between fossil fuels with CCS, nuclear energy, or solar energy, which is much, much more expensive because all the other forms of renewables are insufficient.*

For I8, without close attention to the solar power market, it may indeed have been impossible to see that solar power, in the matter of a few short years, had in many jurisdictions around the world slid below the cost of coal plus CCS.

So why does the story of the 'sneak attack' of renewables matter to CCS? First, in short, the rapid rise of renewables affects the prospects of CCS. For one respondent, CCS technologies operate in competition with others, in particular renewables:

> I18: *… We can use renewables, we can use gas. We can use nuclear. … There's all these different technologies and fuels that are out there in a mix, and they're competing against one another… we're doing a lot of things* to … get experience in these other technologies and we're de-risking them by deploying them, and we're making them more affordable, so particularly renewables. *… and … CCS is standing still…in terms of that learning process, of the learning by doing, its standing still* [emphasis added].

In another respondent's view, a drop in price for renewables, along with natural gas, has already begun to undermine the economic argument in favor of CCS:

> I16: *… Six years ago I think the prospects for …CCS in particular were a lot better than they are now. And most of that is the gas and renewables story. Well if you're going to build a low carbon electricity infrastructure now, you can do it much cheaper now with gas and renewables, than with coal and CCS.*

The case of renewables serves to demonstrate the cost of using "longstanding assumptions" and "not paying attention" within the analytics of government used by mainstream (fossil fuel)

actors in the energy field. That cost is that an analytics based on narrow epistemic grounds, using forms of visibility that are liable to misrecognize factors that can influence its objects of government.[168]

The second reason renewable energy matters to CCS is that it demonstrates that energy scenarios can be read as political strategies. As such, they allow one to see how CCS operates as a fix for the Alberta fossil polity's carbon control crisis. Merchant, reporting on the Meister Group's findings (above), noted another feature of Greenpeace's energy scenarios: "Greenpeace's reports are aspirational, and they make no bones about it." As a spokesperson articulated to Merchant, the scenarios are part and parcel of the organization's political strategy:

> "Everything beyond projections for the next 10 years is simply a political statement from us, indicating what we want to see happen … If we see a renewable energy market isn't performing as we want it to, we'll try to jump in with campaigns—against fossil and nuclear fuels and in favor of renewables" (in Merchant 2015).

If Greenpeace's global energy scenarios are self-admitted "political statements" and aspirational strategies, is it possible that the energy mix scenarios of the IEA, the US EIA, Shell, and others can be read the same way? And Alberta's wedge diagram in its *Climate Change Strategy*? If the implications of a governmentality analysis of discourses and policies, which includes the models, diagrams and calculations that underlay them, are taken seriously then I contend that if they are not unambiguous 'political statements,' they are at least 'aspirational' claims on the future, which reflect energy futures based on present anticipations, which include channelized conceptions of the present and its possibilities.

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[168] In wake of the Meister Consultants Group report on energy futures scenarios, Merchant (2015) asked Greenpeace how they were able to give the most accurate predictions. The lead author of the scenarios, Sven Teske, reported to Merchant that it was because the organization had closely monitored global and national renewable energy capacities and market developments since the mid 1990s. Because the organization was in communication with these industries, they knew "what they have in their order books for the next 3 to 5 years" (in Merchant 2015). In other words, Greenpeace had used a different episteme of government and different forms of visibility to build its scenarios, and in doing so, was better able to recognize factors that can influence its object of government.

6.4.2 Eternally Optimistic, Congenitally Failing: Instrumental and Interpretive Assessments of Carbon Capture as a Political Technological Fix

In section 6.3, I showed that the scale-up and commercial-scale deployment of carbon capture globally has met challenges, set backs and cancellations, and that Alberta was not immune to these trends. The factors that contributed to less-than-hoped-for outcomes in Alberta included the 2008 global economic recession, the fracking and natural gas boom, public ambivalence or resistance to funding CCS, troubles in coordinating buyers and sellers for CO_2-EOR, inadequately robust climate policy and/or compliance costs, low carbon prices, and industry risk profiles. So how does the meager progress of carbon capture in Alberta square with two central contentions of the dissertation – that CCS serves as a political technology to produce new ways of managing complex issues, and that it serves as technological 'fix' that helps state and allied actors temporarily reconcile competing pressure related to the management of carbon? Put differently – if CCS is being used as a fix, has it been done successfully?

The answer isn't entirely clear. In trying to assess whether CCS helped Alberta's fossil polity reconciled competing demands for the management of carbon into order to safeguard growth trajectories, one is faced trying to separate signal from noise. Alberta's access to energy markets is more precarious in 2015 than when it launched its CCS efforts in 2008. For instance, the Keystone XL pipeline that would increase the flow of bitumen to refineries in the United States (and remains a potent symbol of climate change politics) was rejected by U.S. President Barack Obama in November 2015.

Access to European markets, long threatened by the EU Fuel Quality Directive, were finally given 'license' in October, only to be put in question once again (Tencer 2014). Expanded access to Asian markets through the Kinder Morgan and Enbridge 'Northern Gateway' projects is stalled not

only by a fierce debate over pipeline and tanker traffic in British Columbia, but also by increased Asian access to Russian natural gas, and decreasing price differentials. It appears that climate change legitimacy is not the only threat against which Alberta's fossil fuel polity must try to safeguard growth trajectories. Oil prices plummeted in late 2014, and have produced economic reverberations across the global oil sector. It is unclear how long oil prices will remain low, and the medium- to long-term impact on the business model of high-cost oil sands is unknown (Baird 2015, Parkinson 2015b). All of these developments have slowed the ability of Alberta to expand its oil sands operations. They serve to demonstrate that the ability of actors to deploy a particular technological regime as a fix depends is profoundly shaped by exogenous actors and conditions.

In this final section, I attempt to answer the question of how we can evaluate carbon capture as a technological fix, using two different schema for evaluation: (1) the instrumental view that measures project outcomes against programmes; and (2) the interpretive frame, which sees policy programme success as the stabilization of a particular way of interpreting the world, through the enrolment of 'interpretive communities.'

In the instrumental view, policy is a process of rational problem solving, concerned not only with how to realize plans in practice, but also "bringing institutional reality into line with policy prescription" (Mosse 2004: 641). It can be considered a managerial approach because it assumes that the body undertaking a programme of development is one capable of "directly shaping the way in which development is done" (*ibid.*), and assumes project success. Project failure is understood in terms of policy "implementation gaps" (Ridde 2008), which may consist of a "vision gap" stemming from a lack of political/senior commitment, limited financial and human resources or conflicting priorities, or an "accountability gap" (lack of accounting/accountability measures or implementation incentives) (Golder & Associates 2013).

Even from a cursory glance, from an instrumental view, CCS in Alberta has failed. There is a large current and expected gap between plans for CCS to sequester almost 50 Mt by 2020, and likely

amounts to be sequestered. As I have shown, two of the four projects were cancelled. Shell Quest is expect to sequester 1Mt CO_2e/year. The Alberta Carbon Trunk Line is expected to become operational in 2016-2017, but with widely divergent expected annual sequestration capacities, ranging from 1-3 Mt CO_2e/year, depending on the source consulted.

For Mosse, the instrumentalist view does not sufficiently account for the complexity of policy-making and the "implementation black box" (2004: 643). Nor does it pay adequate attention to "the social life of projects," and the diversity of organizations, professionals, interests and perspective behind policies and projects (*ibid.,* 643-4). Mosse offers an alternative policy evaluation schema, an "interpretive" view, that borrows from both governmentality and actor-network theory. This view prioritizes the social relationships through which policies are articulated, and assumes that "(policy) ideas do not have a life of their own apart from institutions, persons and intentions" (*ibid.*: 666).

Within his interpretive framework, Mosse offers five propositions about policy and practice that enable me to evaluate my claim that CCS acts of a technological fix for Alberta's tripartite carbon control crisis. The first proposition is that policy, development strategies and project designs, function primarily "to mobilize and maintain political support" and "to legitimize rather than to orientate practice" (*ibid.,* 648). This accords with what I have already argued about CCS: it is being pursued in the effort to maintain the political legitimacy of Alberta's hydrocarbon based political economy in the face of its triple carbon crisis. I have shown both explicit recognition that CCS is being pursued into order for both the provincial government and some industry actors to maintain social license. I have also shown the way in which CCS figures into the province's climate change policy served to legitimize existing development pathways.

The second proposition – that projects are "driven not by policy but by the exigencies of organizations and the need to maintain relationships" (*ibid.* 651) would explain the differing abilities of the four CCS project industry proponents to navigate challenges to project success (for

instance, TransAlta's cancellation of Pioneer in light of its risk profile). It also speaks to findings in Chapter 4 that showed how CCS evolved from EOR not only through existing social relationships between government, industry and research communities, but also precisely *in order to maintain these relationships.*

The third proposition – that "development projects work to maintain themselves as coherent policy ideas, as systems of representations as well as operational systems" (*ibid.*: 654) helps to account for the model maneuvering done by Alberta Environment and Sustainable Resource Development in order to present a diagram in which carbon capture and storage technology would deliver large emissions reductions, presented in Chapter 5.

Mosse's fourth proposition is that "'success' and 'failure' are policy-oriented judgments that obscure project effects" (*ibid.*: 662). This view should not be taken to mean that policy and projects cannot be evaluated, but rather, that the 'success' should not be evaluated based on instrumentalist implementation criteria. For some governmentality scholars, and those working within critical development studies, the failure of CCS policies, plans and projects to materialize is not unexpected. Above, I presented Li's contention that programs of 'improvement' suffer from the "inevitable gap between what is attempted and what is accomplished" (2007: 21). For their part, Rose and Miller argue that "whilst 'governmentality' is eternally optimistic, 'government' is a congenitally failing operation" (2008: 35). And the reason, they contend, is that "'reality' always escapes the theories that inform programmes and the ambitions that underpin them" (*ibid.*). This assessment matches what I observed for carbon capture advocates, whose theories excluded crucial information about the impact climate policy, wind, solar and natural gas would have on the 'business case' for carbon capture.

To evaluate project 'success' and 'failure,' based on "policy-oriented judgments" leaves out some of the more significant effects of policies and projects (Mosse 2004: 662). For Mosse, development projects are 'successful' "because they sustain policy models offering a significant

interpretation of events, not because they turn policy into reality" (*ibid.* 664). In his view, policies do not so much generate outcomes, as remain sustained by them. For Mosse, failure is not the failure to plans into reality, but instead the consequence of "disarticulation" between policy frameworks, practices, and rationalizing models: "[f]ailure is not a failure to implement the plan, but a failure of interpretation" (*ibid.* 658). A "failure of interpretation" in the case of CCS in Alberta would consist of a disjuncture between the models, scenarios, storylines, and other forms of scientific and legitimating discourses for carbon capture and the political technologies configured to advance carbon capture as an object and instrument of government. I have presented several pieces of evidence over the course of this dissertation that exemplify such disjunctures. For instance, the disjuncture between "$50 billion promise" in ESRD's stabilization wedge diagram, and the $2 billion offered in direct subsidies, or the disjuncture between the cited urgency and essentiality of CCS as a development pathway for Alberta and the (lack of) regulatory response to support it.

In particular, this dissertation has shown that the largest disjunctures with respect to CCS, as Mosse would contend, relate to failures of interpretation, occurring at the discursive level. This leads me to a central argument of the dissertation: technologies are inextricably constituted and conditioned by both the meanings and discourses, and to the historical conjunctures in which they emerge. That is, they are products of their social contexts. This is important because it shows that technological formations are *contingent* – when technologies are articulated within different systems of meaning, or within different social contexts, they may take on a radically different valences, and may, depending on that with which they are articulated, produce radically different effects in the world. In this chapter, I showed that the potential success of carbon capture is limited by the fact that most of its advocates promote it as a second-order goal, which in the face of changes in the socio-technological landscape represents a level of advocacy insufficient to bring about the materialization of the technology is a sufficiently meaningful way.

Mosse's schema for evaluating policies and projects suggests the need to define new terms of success for carbon capture. If carbon capture has been advocated by communities primarily as a fix to overlapping crises, the 'success' of carbon capture policies need to assessed on the basis of whether it successfully temporarily reconciles competing policy demands. Readers might have noticed that of Mosse's five propositions for evaluating projects and policy, I have not presented the fifth and final proposition. I save this for the conclusion, to which I now turn.

Chapter 7: Conclusion – The Labours of Technology

"W*hether it's practical depends on how much we give a damn*."

- Robert Socolow, co-director Carbon Mitigation Initiative, co-creator of the stabilization wedge diagram

"*The Key Ingredient: Sustained Will*"

- Alberta Carbon Capture and Storage Development Council

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- *"[T]ranslation is a process, never a completed accomplishment, and it may … fail."*

- Michel Callon

7.1 Central Findings

This dissertation sought to understand how carbon capture and storage technology operates as a political technology – as an instrument that produces new ways of thinking about and managing complex political issues. To this end, I examined the case of carbon capture in Alberta, arguing for the need to understand three dimensions: (1) existing governance conditions and capacities (political, economic, institutional or technological) that are brought to bear on addressing climate change, discussed in Chapter 3 and 4; (2) changes to existing political and social formations that climate change has already brought about, discussed in Chapter 3 through 6; and finally, (3) how the types of knowledge used to think through the energy-climate nexus configure a governance response, discussed in Chapter 4, 5, and 6.

Overall, both political economic pathways in the form of petro-state dynamics, regulatory capture, and a strong hydrocarbon-based political economy, as well as institutional and related epistemic community (qua provincial research and academic priorities and communities)

pathways, were brought to bear on Alberta's strategy for carbon control. These pathways produced a context of channelized decision-making – the pursuit of CCS as a technological fix - that led actors to promote a carbon mitigation technology that fits within the existing hydrocarbon political economic-knowledge complex of the province.

Conceiving of carbon capture and storage technology as both a political technology and a technological fix leads to draw out seven main findings of the research. First, I found that the motivation to pursue CCS on the part of Alberta's hydrocarbon interests (provincial government, fossil fuel industry actors, and their allies) can be traced to growing civil society demand for addressing climate change. I showed that anthropogenic climate change, as a new 'matter of fact' in the political landscape, has translated to widespread civil demands for cleaner energy production. This has created the need for governments and fossil fuel industry actors to undertake actions to 'address' climate change (which implies the articulation or performance of a strategic response, if not a tangible course of action), lest they lose social license (social legitimacy), which might then entail the loss of market access for their products. Thus, my first central finding is that *climate change, plus the social demands for addressing climate change, and the threat of loss of market access together create a triple 'carbon control crisis,' to which Alberta's fossil polity is compelled to develop a response to.*

Next, given the triple climate crisis facing the province, and the weight given to CCS to mitigate these crises, I found that carbon capture and storage enables Alberta's hydrocarbon community to reconcile a fossil fuel-dependent economic development path with the carbon pollution it produces. This contention led me to the second central finding: that *CCS operates as a political technology (as an instrument that produces new ways of thinking through complex political processes), primarily by serving as a what I call a "technological fix,"* where a fix is an instrument to, for a time, displace a crisis and/or contradictions between competing governance strategies.

By examining the history of the development of carbon capture and storage technology in Alberta, I found that carbon capture was not built *de novo*, but was instead translated from existing oil and gas technology, helping furnish a network of advocates for the technology. This lead to my third central finding: that *the multi-valency of the technology – as an extractive technique (EOR) and/or abatement technique (CCS) - enabled the successful construction of a carbon capture community, willing to advocate for, and enable, the technology*.

I also examined the expanded set of actors that contributed the development of carbon capture in the phase of institutionalization. I showed that the contemporary carbon capture community is not a simple reproduction of hydrocarbon networks, and that to advance carbon capture as a techno-regulatory project entailed needing to draw in additional actors, but also required the labour of the well-established institutions and individuals that exist as hybrids at the industry-government-research hydrocarbon interface. This allowed me to articulate the fuzzy lines that exist between sectors and jurisdictions within the international archipelagos of networked petro-developmental states. This lead to a fourth central finding: *the governance response of Alberta's fossil polity with respect to climate change is being configured as governance both beyond and through the state*.

The fifth central finding was that *CCS enables a continuation of what scholars call a 'path dependence' of fossil fuel dependency not only at the political economic level, but also on the level of knowledge-production* (as well as the career trajectories of experts, bureaucrats, and others). Because CCS arose out of the existing organizational networks of Alberta's hydrocarbon economy, actors a perceived narrow range of options for carbon control. CCS thus constitutes a fix conceived within existing paradigm that helps to strengthen the path of that paradigm at both the structural and epistemological level.

Sixth, I examined scientific and policy storylines and other key discursive elements that help constitute CCS as a political technology. Through an examination of how such discourses are

articulated with, and circulated through, the communities and networks that help produce CCS as an instrument of, and object of, governance, I reached a sixth central finding: *CCS is maintained as a legitimate techno-discursive fix to the extent that storylines are successfully constructed* to make a coherent case for CCS using rationales from science, engineering, and economics. *It is also maintained as a fix to the extent that CCS enables actors to accomplish their first order interests.*

In these final pages, I conclude with a discussion following two threads. In Section 7.2, I address the empirical implications of this research project, suggesting that the apparent failure of CCS to produce meaningful abatements to date does not merit dismissing the technology out of hand. I make the argument for a re-articulation of the relationship between technology and social dimensions, arguing that the prospects of carbon capture depend not on any specific characteristic of the technology, but rather on its larger mediating social context.

In Section 7.3, I make concluding arguments about some of the theoretical implications of the dissertation findings, and offer the seventh conclusion of the research. I consider how the meager progress of carbon capture in Alberta square with two central contentions of the dissertation – that CCS serves as a political technology to produce new ways of managing complex issues, and that it serves as technological 'fix' that helps state and allied actors temporarily reconcile competing pressure related to the management of carbon. I discuss how the failures of CCS provide lessons not only with regard to the practical and pressing task of collectively mitigating climate change, but also with respect to studying state-led projects at the political economy-technological interface.

7.2 Empirical Implications: The Baby, the Bathwater, and the Salvaging of CCS

In Chapter 2, I argued in favour of a view of socio-technical projects that posits that technological objects and projects exist thoroughly in their social context such that the technical

and the social need to be considered as relational, or co-produced. I also argued that there is not a one-to-one correspondence between technology and a particular political program (articulation). Given this view, despite the apparent 'failure' of CCS to act as a technological fix for Alberta's carbon control crisis, both in the instrumental and interpretive sense, here I argue that one can still advocate for the continuation of support for CCS as a mitigation technology. I make a case for salvaging CCS from it current trajectory, arguing that it can play a valuable role in an ecologically and socially just future. This would require a change in the types of "practical rationality" (expertise, knowledge and skills), and regimes of practice (institutionalized set of practices), into which carbon capture would be inserted. In short, I argue that the bathwater out to be tossed, while the baby, at least as a "fractional coherence" (Law 2008) of itself, ought to be nurtured.

As Law's formulation of techno-social objects would suggest, as fractional coherences, technologies themselves (through differing articulations to their contexts) can change, and can exist as different 'phenotypic' expressions depending on the social context (as demonstrated by the description of the variable forms of carbon capture and storage in Section 1.1). The private automobile, for instance, maybe one of the chief threats to the climate at present, but what about a PEV (plug-in electric vehicle) connected to a fully renewable grid? This is still a private automobile, however, it is one created with different technological and social constituent parts that produces some of the same relations in society at gasoline vehicles (private hypermobility, suburbanization), yet not others (tailpipe greenhouse gas emissions, particulate matter pollutants).

The PEV example demonstrates that technological objects are not stable or static physical entities, but instead, socio-technical objects whose physical attributes and relation to other aspects of the social field can change if there are changes to social priorities about their composition and effects. This enables me to argue that carbon capture and storage is a technology that those concerned with climate stabilization ought to view as a valuable tool albeit with changes to its scale and application. Why?

The current standard conception of carbon capture and storage technology is as a large integrated technological assemblage of capture technologies mounted on large industry facilities, connected by pipeline to industrial scale storage configurations (see Section 1.1). However, there are others ways of imagining CCS technology, ones that might help societies achieve the kinds of greenhouse mitigation called for by climate science. CCS can also exist as passive (free air) carbon capture, or as CCS used in tandem with bio-energy (BECCS) (Gough and Upham 2011). While I don't advocate for the use of BECCS here (simply because it is beyond the scope of the research project), I suggest that there is potential for, and perhaps even need for passive (free air) carbon capture. Several of my interview respondents dismissed the feasibility of passive air capture, arguing the energy penalties were too high. Yet geophysicist Klaus Lackner, from Columbia University believes that "yes, we can afford to remove carbon from the air" (2011). A 2015 article rearticulated Lackner's proposition for passive (free air) carbon capture, calling it an "idea worth consideration" (Holthaus 2015). The author argued that while free-air capture was currently much more expensive than other carbon-reducing technologies," that, "like solar power, the cost of free air capture is rapidly decreasing," making a free air carbon capture industry "viable in just years" (*ibid.*) (albeit, likely only with "an economy-wide price on carbon").[169]

Some climate and energy analysts argue cheap free air capture might be necessary. One commentator, for instance, argued that "driving fossil fuels out of the global electricity mix will ultimately require everything we've got: renewables, nuclear, and even CCS" (Jenkins 2015). The reason? The latest IPCC Major Assessment, the IPCC 5th Assessment, released in late 2014, calls for "net negative emissions by 2100" in order to reach the estimated emissions levels to stay within a

[169] But if the costs of free air capture are rapidly decreasing, wouldn't the cost of industrial CCS installations also be falling rapidly? Not necessarily, according to energy policy analyst Amory Lovins, in his classic piece that distinguishes between 'soft' and 'hard' energy technologies (1977). Because free air capture units are relatively small and relatively inexpensive, they can be mass-produced. This brings down per unit costs more easily than the large units attached to industrial process, which need to be customized in almost every case, eliminating the savings in per unit costs attainable through mass production.

target of 450 ppm. Freedman (2014) reports that the initial draft of the upcoming Paris global climate agreement contained "several references to net zero or negative emissions after 2050."

Given the already demonstrated multi-valency of carbon capture and storage and associated technology, therefore, I argue that while one certainly needs to dispense with the bathwater, one might still want to save the baby. I advocate for agnosticism about the value of the technology itself, arguing that what is climactically unsound about CCS is not the technology, per se, but the particular techno-social arrangement one typically finds it.

7.3 Conceptual Implications: A Socio-Technical Struggle for an Uncertain Future

In the last chapter, I showed both numerous factors that helped account for the success of CCS as a state climate change strategy, as well as the challenges and failures that make the future of CCS in Alberta, and in other settings, uncertain. While arguing that CCS failed as a carbon control strategy using an instrumentalist view, I did not explicitly argue whether it has succeeded, failed or otherwise using an interpretive frame. This because such an evaluation is subject both to the difficulties of separating signal from noise, and because, as I conclude here, one can only evaluate the success (or lack thereof) of a technological project by evaluating the constellation of social relations and networks in which the project is embedded.

These social relations constitute Mosse's fifth proposition for understanding the success or failure of projects. Mosse contends that, "projects do not fail; they are failed by wider networks of support and validation" (2004: 658). Thus, a crucial basis of assessment of the ability of CCS to successfully perform as a fix for the actors that support it is the actors themselves. In Chapter 5, I showed that although the network of actors who laboured across time and space to produce CCS as a technology formed a sort of strategic coalition of 'enthusiastic proponents' that produced a 'common sense' about CCS, their respective first-order goals, beliefs and interests were sufficiently

divergent to make them functionally 'reluctant advocates' in the face of setbacks and challenges to carbon capture. For many actors, the realization of operational carbon capture projects may be a second order goal, and the failure for CCS to actually materialize is immaterial. Quasi-materiality, for many actors, is enough.[170] Thus for some member of the CCS advocacy community, the failure to realize significant emissions reductions from carbon capture does not correspond to a failure of their interests. For others, failure may bring its own success (for example, if project cancellations lead to renewed rounds of investment in carbon capture and storage research funding or project funding). In this way, one can argue that, in trying to determine whether the project of developing CCS in Alberta, in terms of 'success' and 'failure,' one needs a third option: that of 'failing forward' (Peck 2013). Borrowing from Peck's use of the term to describe some economic neoliberalization projects, failing forward refers to the ways that policy proponents may "find ways of capitalizing on [the policy's] own contradictions," and to exploit crises – like Alberta's carbon control crisis, which are of the actors' own making (*ibid.*).

This proposition corresponds with the same measure of success and failure used by Latour to evaluate socio-technical projects. For Latour technologies and scientific undertakings do not fail, per se, but rather fail when proponent actors fail to help sustain the quasi-object through the changing social terrains and contexts in which it is developing. Latour explains this thesis in his 1996 work *Aramis, or the Love of Technology*, a quasi-fictional mystery in which an engineer-detective attempts to discover who 'killed' Aramis. Aramis was a Personal Rapid Transit (PRT) system (a sort of detachable amalgam of a subway and a personal vehicle) that was supposed to be

[170] Bouzarovski and Konieczny (2010) argue that development projects operating through state policies operate in a "quasi-material" fashion: even whilst existing only as plans or blueprints they can begin to produce effects in state decision-making. In describing the effect of the (then) proposed Nord Stream gas pipeline on Polish and eastern European regional politics, they claim is that energy infrastructure projects can affect national and regional spaces not only directly (through the physical structures), but also indirectly, "by affecting national economic development and energy policies," thereby "produc[ing] space in material and discursive terms alike" (2010: 17). For example, for actors whose interest in carbon capture was translated from their interest in CO2-EOR (Chapter 4), interests can always be reshuffled back to CO2-EOR if avenues for carbon capture dry up. Or, for the Government of Alberta, the need for a climate change policy that serves the purpose of signaling action on climate change is more important than a successful carbon capture program that realizes such action.

built in Paris, but failed to successfully make it from the drawing board to the streets. Throughout the book, the engineer-detective, Norbert, interviews all the actors who had been involved in the development of Aramis – from train engineers, to aeronautics company executives, to national transportation ministers, and others – trying to figure out which actors and agencies, led to the technology's failure. In the concluding chapter the engineer-detective sits all involved actors down to "name the perpetrator" (1996: 289). Norbert's findings reveal something with great relevance to our case:

> "Aramis has been fragile from the outset – we all know that; not fragile in just one respect, in one weak link, as with other innovations, but fragile on all points… The demand for it is undefined, the feasibility of the vehicle is uncertain, its costs are variable, its operating conditions are chancy, its political support – like all political support – is inconsistent… Yet in spite of its fragility, its sensitivity, how have we treated it? Like an uncomplicated development project that could unfold in successive phases from the drawing boards to a metro system … Here is our mistake, one we all made, the only one we made. You had a hypersensitive project, and you treated it as if you could get it through under its own steam… You believed in the autonomy of technology" (1996: 291-2).

Norbert was arguing that Aramis was 'killed' when proponents failed to help sustain it through the vagaries of technological and project development – disappearing budgets, shifting political priorities, competing technologies, uncertain costs and so on. There is a clear link between Norbert's assessment of the deadly threats to Aramis, and my analysis of carbon capture and storage in Alberta, where the provincial government has shifted priorities away from carbon capture, drying up further funding, and where the oil and gas industry has opted for higher return fracking technology over enhanced oil recovery, among other shifting circumstances.

In the course of completing this dissertation, I came to know that making any sense of whether CCS failed, or would fail forward, or would come to re-emerge as a fix, would depend on the unfolding of history. As late as May 2015, I found it would be difficult to pronounce for sure whether the Alberta CCS proponent community 'killed' carbon capture. Now, from the vantage of December 2015 – with several significant historical events having come to pass (which I discuss below) – it seems possible to argue that the project of developing CCS in Alberta has failed.

First, in May 2015, the citizens of Alberta elected a New Democrat (NDP) majority to the legislature. This was the first change in government in the province in forty-three years. While it is outside the scope of the work to speculate on the range of factors that led the voting population to change governments when it did, it can be said that the election of the progressive-leaning party, and leader Rachel Notley, signaled a mandate from the population for the provincial government to make changes to the ways in which Alberta's hydrocarbon-based political economy operates. This mandate extended to the provincial approach to climate change, and in the summer of 2015, the new Environment Minister, Shannon Philips, initiated a process to guide the government to produce a new climate change strategy in time for the UNFCC COP-21 in Paris in December 2015 (Leach 2015).[171] From August to November, the expert Advisory Panel she struck worked to solicit feedback from all stakeholders on what Alberta's overdue plan should look like, signaling publically that she intended to create a plan that was "ambitious, effective and achievable," and that would be considered a credible climate plan to the international community in Paris.

[171] The now ousted Progressive Conservative government was supposed to release a new strategy in 2014. In late 2014 the Prentice government extended Alberta's carbon regulations until June 2015. Prentice indicated in early 2015 that, "Albertans will see climate change strategy 'when it's ready,' (Ibrahim 2015). Many journalists have criticized the Progressive Conservative's failure to initiate a new solution or institutional fix for the carbon control crisis. In 2014, Jones reported that, "Alberta needs to get the message on carbon," arguing that ESRD's progress lack of progress in implementing actions necessary to achieve targets from the 2008 *Strategy*, "does not reflect the significance that effectively managing climate change has for the economy and environmental performance in Alberta and in Canada." Jones called bluff on the government's "rallying cry" for "market access for oil sands derived crude," arguing that foot-dragging on the climate issue signals a lack of appreciation for the seriousness of the threat of market access.

The climate plan the Alberta NDP announced on November 22 was at the far end of what many environmentalists and political progressives considered politically possible. The plan is far from aggressive enough to land Alberta where many of its peers intend to be by 2030, and what science seems to demand the world move to by that time, but it was historic. For the first time, it set production limits on Alberta's oil sands sector, and if enacted, it will represent substantive progress on Alberta's emissions profile. For our purposes, carbon capture was not mentioned once in the 97-page report released by the Advisory Panel in conjunction with the announcement, nor was the technology mentioned once by the Premier or Minister Phillips in their speeches.

Meanwhile, in October, the federal election saw Prime Minister Stephen Harper ousted after 9 years in power, to be replaced with a Liberal majority led by Justin Trudeau. While climate change figured quite low in the campaigns of all the three major parties, it nonetheless became clear in the days after being elected that Trudeau was taken the upcoming talks in Paris seriously. First, he changed the name of the federal ministry in charge of the file from Environment Canada to the Ministry of Environment and Climate Change, and appointed as Minister of the file Catherine McKenna, whose career has involved social and environmental advocacy. Next, by most accounts, Trudeau's delegation to the Paris talks seems to a signal Canada's return to international climate talks as a sincere negotiator. This is signaled, among other things, by McKenna's advocacy and support to change the international warming target from 2 to 1.5 degree Celsius.

The price of oil has also cast its shadow on the future of Alberta's oil sands. Through what appears to be a combination of Saudi strategy and the continuation of the U.S. shale oil boom, oil prices (both West Texas Intermediate and Brent) began to tumble from the resulting supply glut. The year of low oil prices has already stressed Alberta producers, who are considered high-cost in world standards. And given that oil prices could remain low until 2017, 2020, or even longer, means that the original envisioned place of CCS as a means to offset predicted large increases in emissions from an aggressive continued ramp-up in production, could be (permanently) made null.

Together, the change in government at the provincial and federal level, and the step-change in these respective government's approaches to climate change, along with the glut in oil prices, have left carbon capture and storage technology off the table. It appears that the carbon control strategy of the previous Alberta government – to address its triple carbon crisis through CCS – has been displaced by an emerging new strategy from the new government. This strategy appears to be one of reconciling a high-carbon economic pathway and the need to address climate change by a combination of concessions to demands for higher environmental performance in the oil and gas sector, combined with emissions mitigation measures in other sectors of the economy (notably in the coal-dependent power production sector), and an emergent strategy to direct and diversify the economy towards lower-carbon activities. Further research would be required to determine where these historical events have left the existing Alberta CCS community and its desire to pursue the technology.

Thus, the seventh central finding of this work is that, ultimately, Alberta actors were limited in their success at addressing the carbon control crisis, and that *the project of developing carbon capture in Alberta* (through the *Climate Change Strategy*, the $2 billion subsidy, and the regulatory assessment) *was, overall, a failure of carbon control and a failure to address the province's triple carbon crisis*. I showed that of some of the very factors that led to its rapid ascendancy as a carbon control measure – a resource strong advocate community, its continuity with an existing political economic pathway, and others – made it susceptible to disruption from exogenous events, notably a climate policy vacuum and competition from other energy technologies. The need to address carbon control was a result of a triple climate crisis. This crisis constitutes an example of changes to existing political and social formations that climate change has already brought about, in the form of not only the decreasing social support for oil sands production, but also consequent market access, not to mention recent sharp drops in the price of oil, all of which threaten the viability of Alberta's high-cost, high-impact oil.

So how the meager progress of carbon capture in Alberta square with two central contentions of the dissertation – that CCS serves as a political technology to produce new ways of managing complex issues, and that it serves as technological 'fix' that helps state and allied actors temporarily reconcile competing pressure related to the management of carbon? The evidence I have presented in this research demonstrates that the ability of CCS to act as fix for a carbon control crisis depends as much, if not more, on the social context in which CCS is articulated that any 'technological' feature it possesses. And that is essentially the point Latour's figure Norbert makes when concludes that proponent actors' failure was not only failure to 'sustain' support for Aramis, but failure through misrecognition: "… [y]ou believed in the autonomy of technology." Norbert elaborated upon this when he continued, "don't ask a project to do something you, as individuals and corporate bodies, find yourselves incapable of accomplishing. Either you change the world to adapt it to the nominal Aramis, or else, yes, you need… to change Aramis" (Latour 1996: 292). This contention points us to is the problem of the 'will to improve' through technicalization, which sees technology itself as capable of 'fixing' problems without due consideration to the thoroughly social factors that lead to the need for the fix, or that support and help constitute the technology. It also points to the perils of misrecognition that are liable to arise when the political rationalities used as a basis for a political technology are based on narrow epistemic grounds.

But beyond these conclusions, what this dissertation has shown perhaps most clearly is that even when a technology and/or technological fix has very powerful interests aligned behind it, no outcomes are pre-ordained. And further, the reasons that such technologies fail to take off are more intriguing than the standard story of technological and capitalist triumphalism. The case of CCS in Alberta has shown that despite a respectable historical pedigree, ample resources, the assistance of a broad spectrum of expertise, provincial, federal, and international institutional support, legitimating storylines, justifying science, legislative support and more, 'technological fixes' are not the all-powerful high modernist successes that proponents might assume or dream, or that critics

or skeptics might fear. Instead, my case shows that projects and policies with the support of economic, political and scientific elites are "situated and contingent achievements" (Greenhough 2011: 135). As a result, the 'will to govern,' argue Rose and Miller, "needs to be understood less in terms of its success than in terms of the difficulties and the variability of operationalizing it" (2008: 35), something that can only be revealed by "uncovering the labour and materials involved" in projects (Greenhough 2011: 135).

Projects and policies like the Alberta government's plan to deploy CCS as a carbon control measure are "a result, often a fragile one, of social processes" (Mosse 2004: 664), and not the result of (simply) technical feasibility or engineering problem-solving. The task for those wishing to understand how technical projects become incorporated into political and policy processes, therefore is to understand the modalities through which any 'techno-fix' will be haunted by the specter of its thoroughly social origins. There is no successful technology without a social community that supports it, sometimes fervently, and who come to labour for the needs of the technology in order to ensure its continued social reproduction. What the case of CCS in Alberta shows is that the labours of technology – those tasks infrastructures, physical capital, hardware and technological devices are asked to perform are, in the end, still simply labours: they require ongoing social production and reproduction, both to operate, and to operate *as though* they were simply technical. This, I argue, is the central lesson social scientists can learn from this dissertation, with respect to studying state-led projects at the political economy-technological interface.

Whatever the eventual outcome of actors' efforts to pursue carbon capture and storage, how does one understand the significance of Alberta government and allied actors' strategy to address climate change with this technology? In the introduction I relayed a productive framework offered by Beck and van Loon (2010); they suggested that social scientists should spend less time studying "the future of catastrophic climate change to come," and instead focus on "the present anticipation of a catastrophic future" (2010: 113), which can be studied empirically.

This research project has focused on the 'present anticipation' of a group of dominant social actors – a hegemonic bloc of hydrocarbon interests including a landlord state, the industries to from whom it extracts resource rents, and professionals from their associated centres of knowledge production, and the manner in which they developed a particular social-technical response to a crisis that threatens the dominant economic pathway. But I also showed while the primary subjects of my study were this group, their strategy was ultimately based on a legitimacy crisis in the sphere of civil society. Put differently, one might be led to believe that the story of CCS in Alberta is by and large one of a 'well-oiled' elite hydrocarbon alliance. However, if one takes at face value the hydrocarbon community's very real concern about "social license to operate," then public pressure, I argue, is an important, crucial, and *antecedent* explanatory variable in the story of CCS in Alberta. As the preceding discussion has shown, given that the desire for a social license to operate is a key stated motivation for pursuing CCS, civil society and environmental groups are, in fact, a key, if veiled, actor in the CCS story. Although though told through the technical narratives of graphs, energy forecasts, expert deliberations, and subsurface characterization models, *CCS is actually about a social struggle to reconcile fossil fuel-dependent social formations and economies with the environmental and social justice demands of climate change concerns*.

As Gavin Bridge and Andrew Jonas argue in their study of the neoliberal rationalization of extractive industries, "the challenge is to show how differences within the emerging regulatory landscapes of resource provision are constructed through specific geographies of struggle… [between] differentially constrained agents in specific places" (2002: 761). Similarly, in their analysis of the role of popular movements in hydrocarbon resource conflicts in Ecuador and Bolivia, Perreault and Valdivia show the ways that "the frictions of hydrocarbon-generated capital," including the political dissensus it generates, "shape its governance" (2010: 298). Therefore, the story of CCS in Alberta – a story full of bureaucrats, engineers and CEOs – must be seen as a story of social struggle. Chapter 3 and 6 demonstrated the unreliability of energy modeling scenarios. I

showed that such unreliability was not just based on the political aspirations of authors, or errors in predicting demand or price due to poor input data. It is also because, as several writers have suggested, climate and energy models tend to exclude social feedback parameters.[172]

It would seem that the very necessity of a climate change strategy for fossil fuel polities signals a perhaps irrevocably alteration to the political economic terrain in which it operates; in the "new reality of oil" (Bridge and Le Billon 2012) the climate is now a permanent political concern that threatens the social legitimacy of fossil fuels. I showed that carbon control strategies that do not fully account for this new reality (which includes a rapid decline in the social legitimacy of fossil fuels and the rapid ascendency of clean power capacities) are likely to fail both instrumentally and as fixes, whether or not they are backed by networks of powerful actors. And this, I argue, is the central lesson the failures of CCS provide with regard to the practical and pressing task of collectively mitigating climate change.

Overall, this dissertation has sought to investigate how things come to "matter," in both senses of the word (Greenhough 2011). At the outset, I stated that the project was based on the supposition that by studying the trajectory of CCS, one would be able apprehend larger the social and political context in which it is unfolding, and in the process register a number of important features about the contemporary political geographies of climate change, energy, and contemporary politics more broadly. I demonstrated how CCS came to matter quickly as a discourse and as a technoscientific project for many powerful actors in Alberta. But I also argued that carbon capture as a matter of concern for these powerful actors has not translated into physical manifestation. This was due to both exogenous factors (such as advances in other technologies like solar, wind and hydraulic fracturing) and endogenous factors, like the failure of

[172] For example, several commentators have attributed part of the Government of Alberta's new downgraded oil sands growth projections to the fact that earlier forecasts and "resolutely ignored popular resistance to the resource's carbon liabilities" (Nikiforuk 2013; see also Klein 2014).

the carbon capture community to advocate for the policy and regulatory supports that would be necessary to produce a compliance cost for carbon high enough to incent uptake of the technology.

Although this dissertation has "studied up" to focus on the carbon control strategies of industry, government, intellectual and bureaucratic elites, it must be remembered that CCS has come to matter because of the antecedent alarm, concern, and political action of scientists, ENGOs, consumers and citizens. As Sheila Jasanoff has argued, it is the paradigm, rather than any particular feature of the world, that "defines what problems are worth solving" (2004: 13). The case of CCS in Alberta has shown that climate change is a problem that actors know needs to be addressed, at multiple levels. It has also shown that Alberta has yet to properly articulate a political technology and a paradigm adequate to address that problem within the current political economic arrangement. For the time being, in this arrangement, the rule of experts dictates that the critical socio-ecological issue of our time be configured as a technical problem.

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