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THE RISE AND FALL OF CARBON EMISSIONS TRADING
DECLAN KUCH

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The Rise and Fall of Carbon Emissions Trading

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To my family

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Series Editor's Preface

Concerns about the potential environmental, social and economic impacts of climate change have led to a major international debate over what could and should be done to reduce emissions of greenhouse gases. There is still a scientific debate over the likely *scale* of the severity of climate change, and the complex interactions between human activities and climate systems, but global average temperatures have risen and the cause is almost certainly the observed build-up of atmospheric greenhouse gases.

Whatever we now do, there will have to be a lot of social and economic adaptation to climate change – preparing for increased flooding and other climate-related problems. However, the more fundamental response is to try to reduce or avoid the human activities that are causing climate change. That means, primarily, trying to reduce or eliminate emission of greenhouse gases from the combustion of fossil fuels. Given that around 80 per cent of the energy used in the world at present comes from these sources, this will be a major technological, economic and political undertaking. It will involve reducing demand for energy (via lifestyle-choice changes – and policies enabling such choices to be made), producing and using more efficiently whatever energy we still need (getting more from less), and supplying the reduced amount of energy from non-fossil sources (basically switching over to renewables and/or nuclear power).

Each of these options opens up a range of social, economic and environmental issues. Industrial society and modern consumer cultures have been based on the ever-expanding use of fossil fuels, so the changes required will inevitably be challenging. Perhaps equally inevitable are disagreements and conflicts over the merits and demerits of the various options and in relation to strategies and policies for pursuing them. These conflicts and associated debates sometimes concern technical issues, but there are usually also underlying political and ideological commitments and agendas that shape, or at least colour, the ostensibly technical debates. In particular, technical assertions at times can be used to buttress specific policy frameworks in ways that subsequently prove to be flawed.

The aim of this series is to provide texts that lay out the technical, environmental and political issues relating to the various proposed policies for responding to climate change. The focus is not primarily on the

science of climate change or on the technological detail, although there will be accounts of the state of the art to aid assessment of the viability of the various options. However, the main focus is constituted by the policy conflicts over which strategy to pursue. The series adopts a critical approach and attempts to identify flaws in emerging policies, propositions and assertions.

The present text certainly looks at an area where there is no shortage of disagreement about policies – the attempt to develop a carbon trading system in Australia. The highly charged political context is provided by its coverage of the introduction in 2012 of a greenhouse-gas emissions trading scheme and its subsequent demise following a change of government. Carbon trading is seen by some as a market mechanism that ought to appeal to those on the political right, but it is also inevitably seen as device for reducing fossil fuel use, and thus is suspect to those who do not believe that climate change is man-made. The polarization of views seems very strong in Australia, which, although ideally situated to exploit solar energy, is heavily dependent economically on its fossil-fuel extraction activities, while also suffering from increasingly extreme weather episodes. However, even within the context of looking to amelioration and mitigation measures, there are disagreements about how best to proceed. The EU Emissions Trading System (EU-ETS) has demonstrated that, without tight carbon caps, emission reduction will be limited. Within the EU there are still calls to try to rescue the EU-ETS, but devising effective schemes that can work in politically charged situations is not easy. That is one of the lessons provided in this book in relation to the fate of the Australian system. With climate and energy policy there and, indeed, around the world, still very much in flux, this is a very timely overview of the issues, from both a practitioner's and analyst's perspective.

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List of Abbreviations

ABS	Australian Bureau of Statistics
ACF	Australian Conservation Foundation
AGO	Australian Greenhouse Office
AIJ	Activities Implemented Jointly: Voluntary pilot phase of the flexible mechanisms that allowed industrialized countries (Annex I Parties) to implement projects in other countries that reduce emissions of greenhouse gases or enhance their removal through sinks.
ANC	Acid Neutralizing Capacity
CAAA	Clean Air Act Amendments
CDM EB	Executive Board of the Clean Development Mechanism: an institution with wide-ranging powers, including deciding on rules and modalities for project eligibility such as assessing methodologies for baseline measurements against which emissions reductions can be claimed.[1]
CDM	Clean Development Mechanism: Article 12 of the Kyoto Protocol establishes a mechanism whose role is to assist industrialized countries (non-Annex I Parties) in achieving sustainable development and in contributing to the ultimate objective of the convention, and to assist industrialized countries in achieving compliance with their quantified emission limitation and reduction commitments.
CEGB	Central Electricity Generating Board of Britain.
CER	Certified Emission Reduction: a permit issued by CDM administrators to equal to one metric tonne of carbon dioxide equivalent, calculated using global warming potentials from the 1995 IPCC Second Assessment Report.
CFL	Compact Fluorescent Lightbulb
COP	Conference of the Parties – highest-level meeting of signatory parties (nation-states) to the Kyoto Protocol
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEAF	default emissions abatement factor
DICE	Dynamic Integration of Climate and Economy
DNA	Designated National Authority: certifies CDM projects according to nationally defined sustainability criteria

DOE	Designated Operational Entity: private company responsible for auditing project documents for CDM registration
DSA	Demand Side Abatement rule under the NSW GGAS
ESD	Ecologically Sustainable Development
ESF	Electricity Sales Foregone
ETS	emissions trading schemes
GWP	Global Warming Potential
IAMs	Integrated Assessment Models
IPART	Independent Pricing and Review Tribunal – NSW utility regulatory body responsible for both the compliance and audit of the NSW GGAS
Kyoto Units	Each flexible mechanism of the Kyoto Protocol has units intended to represent one metric tonne of CO_2 equivalent. Jurisdictions vary on their allowance of Kyoto Units for compliance with domestic climate legislation. A CER is the Kyoto Unit for the Clean Development Mechanism.
LRTAP	Long Range Transboundary Air Pollution
LULUCF	Land-use, Land-use Change and Forestry
NAPAP	National Acid Precipitation Assessment Program
NCAS	National Carbon Accounting System (Australian)
NEM	National Electricity Market
NGAC	New South Wales Greenhouse Abatement Certificate: the tradable instrument of the NSW Greenhouse Gas Abatement Scheme
NGMC	National Grid Management Council
NGO	non-governmental organisation
NGRS	National Greenhouse Response Strategy (Federal)
NRM	Department of Natural Resource Management
NSW GGAS	New South Wales Greenhouse Gas Abatement Scheme: Emissions trading scheme using a government set baseline of greenhouse gas emissions against which credits could be created by participants. This type of scheme is also known as a 'White Certificate' Trading Scheme.
NSWAO	New South Wales Audit Office
PDD	Project Design Document: project developers under the CDM must first establish a document describing the project, the baseline methodology, the duration of the project, a monitoring plan, an estimate of the anticipated reductions, the environmental impacts of the project, evidence of stakeholder consultation and a number of other parameters.

RAINS	Regional Air Pollution Information and Simulation
REDD	Reduced Emissions from Deforestation and Degradation: one of the proposed international financing mechanisms to offset industrial emissions by sponsoring an array of governmental techniques to prevent deforestation of a certain area of land.
SEDA	Sustainable Energy Development Authority
SLATS	Statewide Landcover and Trees Survey (Queensland)
TPA	Trade Practices Act
TWS	The Wilderness Society
UNFCCC	'United Nations Framework Convention on Climate Change': (signed 1992, entered into force 1994) establishes the commitment by signatory countries to avoid dangerous interference with the climate system.
WWF	World Wildlife Fund

Note

1 The Foundation for International Law and Development outlines the full range of their powers here: http://www.cdmguide.net/cdm16.html (accessed 15 January 2010).

Introduction

Rationale for this book

The research for and writing of this book coincided with two important events in Australian climate-change policy. The book's final sections were written in mid-2014, as the Liberal National Coalition completed its repeal of a carbon-pricing package that had been years in the making. The centrepiece of this package, passed in 2012 by the Australian Labor Party minority government with the Greens, had been the introduction of a greenhouse-gas emissions trading scheme. The passage of this legislation was important because it was the first time Australia had a coordinated set of national regulations designed to restrain greenhouse-gas emissions, culminating two decades of debate about such economic and environmental measures (Wilkenfeld, 2007).

The second important event directly relates to the future of carbon markets. My research commenced in earnest shortly after the Liberal prime minister, John Howard, established a task group in December 2006 to reduce greenhouse gas emissions through a trading scheme. Howard's plan was momentous because it signalled a commitment from both major parties to introduce a carbon-pricing mechanism. The group's terms of reference included, most notably in terms of my argument, the preservation of Australia's 'major competitive advantages through the possession of large reserves of fossil fuels and uranium'. I had spent much of the previous two years working under an existing carbon emissions trading scheme, arguably the world's first: the New South Wales Greenhouse Gas Abatement Scheme (NSW GGAS), whose origins and 'technopolitics' of market design are assessed in Chapter 3. My experience had taught me that details mattered when assessing the merits of policy proposals. The implications of a carbon price are only apparent when the details of it are fleshed out.

Detailing emissions trading scheme design is important because seemingly minor changes in rules may be the difference between a scheme operating as intended, or as one that merely lines the pockets of industry. Analysis of such details should not mean discarding 'big' concepts such as neo-liberalism, capitalism or the state, or 'middle range' concepts (Merton, [1949] 2004) such as regulatory capture; instead, this book aims to show their value historically. With a stream of new books being published that are critical of specialized climate policy responses (such as carbon markets), the present book's guiding principle is to challenge the place of history in this emerging field. History animates our narratives of progress, ideas of governing, concepts of value and notions of agency.

A number of preliminary distinctions help establish what this book puts at stake. What is often referred to by politicians as a 'carbon price' or 'carbon trading' can be disaggregated into two quite separate designs and institutional arrangements. A 'cap-and-trade' scheme refers to the setting of an agreed 'cap,' or limit, on the emissions of a group of entities, such as firms emitting a certain amount of greenhouse gases or gases that cause acid rain. These firms are then allocated permits which they can, in turn, trade. Economists term this cap a 'quantity instrument' (Stavins, 2003) because the law ostensibly guarantees a quantity of emissions will be reduced. On the other hand, a 'baseline-and-credit' scheme (or 'White Certificate') sets agreed methodologies for measuring a level of emissions at some sites – such as power stations or timber plantations – against which net changes in emissions generate credits. These credits are known as 'offsets' when used by an organization to justify continuing emission of an equivalent quantity of greenhouse gases, for example. Capping emissions for some industrial sector or jurisdiction, or setting baselines, requires attentiveness to the details of measurement and other minutiae.

However, what appears elegant in economic theory textbooks has proven to be much more disorderly in the world of policy. One key reason involves disagreements over the use and validity of offsets. Contemporary carbon emissions trading schemes have overwhelmingly relied on a combination of permits and offsets.[1] Ostensible cap-and-trade schemes, such as the European Union Emissions Trading Scheme (EU ETS), transform the credits earned from international offset mechanisms into permits to be traded within the scheme. The significance of the institutional entanglements between caps and offsets should not be underestimated. The distinction between 'cap-and-trade' and 'offsets' can be understood insofar as it corresponds to two competing logics:

cap-and-trade implies a transformation or transition towards an agreed goal; offsetting, however, relies on ongoing expert assessments against a set of rules. Experts, in short, must reconcile proposed projects with regulations. The term 'reconcile' is particularly felicitous because it evokes a fetish for numbers and the mythology of numerical objectivity characteristic of offset accounting, as in reconciling receipts with income.

The logic of emissions trading sees public experts paradoxically dispense with using neo-liberal arguments against 'central planning', whilst experts are summoned to calculate and assess the validity of offsets. Critics of carbon markets have argued that the lobbyist traders and certifiers reliant on certifying offsets are a deadweight loss to the economy (Lohmann, 2008; Lohmann, 2010). Thus, carbon markets may establish a dangerous precedent whereby the opportunities for making money by trading certificates rely on maintaining GHG emissions, not reducing them (Spash, 2010b).

This book uses case-study analysis guided by the concept of technopolitics – namely, that the politics of climate-change mitigation goes much deeper than the headline questions of much existing climate policy such as the use of a tax or trading scheme (MacKenzie, 2009b: 175). A technopolitics approach suggests that politics does not begin and end with ostensibly political decisions, but rather that political schemes gain political acceptability by providing closure to such questions as: Which emissions and sequestrations will be covered by the scheme? Of those covered, which industries, social groups or communities are worth protecting from the impacts of the regulation? How can such protection be justified in terms of contributing to the society's profile and standing? How much compensation will be necessary for these industries or social groups? How many permits or offsets are firms allowed to submit to comply with their regulatory obligations? These questions comprise a politics of market design that determines the boundaries between the imperatives of economic transformation and the intransigence of mere reconciliation.

However, this book does not simply describe technical details of emissions trading schemes as they intersect with the political and economic. Rather, it shows how facts are implemented practically through experts. Emissions trading schemes assume the form of practices in areas such as the measurement of trees for mining companies, installing energy-efficienct light bulbs in residential areas and interpreting satellite remote-sensing data. There is no straight line between economic theories of carbon reductions and their implementation in any of these cases. Concepts of efficient trading schemes and robust climate policy

must be modified and translated as they meet political considerations and technical constraints. Such movements between the technical, political, economic and scientific tend to be overlooked in much of the political-science literature, which operates within the fields of states and markets.

Beyond the immediate questions of technopolitics, therefore, this book addresses underlying questions such as: How and why (through what alliances and practices) have specific pollution control regimes been formed? What resisted their formation? How was the authority of particular material and practical representations of carbon equivalence established?

The politics of market design implicit in these latter questions confronted me while I was working in the NSW Greenhouse Gas Abatement Scheme, discussed in detail in Chapter 3. This scheme was ostensibly a baseline-and-credit scheme that built on an earlier, smaller scheme by adding a number of offset provisions. My work under the scheme mainly involved installing energy-efficient light bulbs and showerheads in residences around New South Wales. Mine was one of many small teams darting around Sydney in hired vans full of compact fluorescent light bulbs (CFLs) replete with forms nominating the carbon trading company as the owner of the saved electricity, and therefore coal fired power emissions, to be signed by the electricity bill payer in each household. The forms credited the electricity savings made by the bulbs to my employer, who then sold the savings, at a substantial profit, as a certificate to electricity retailers, who were then liable to meet certain benchmarks for greenhouse-gas reductions under the scheme.

As I knocked on doors from Artarmon to Zetland plugging the free service, I was often welcomed by residents simply willing to 'do their bit' for the environment without question. Occasionally I was quizzed about the fine print on the nomination forms, which usually led to a discussion about the byzantine nature of the scheme. The more-informed customers asked why we were only bothering with light bulbs, which only made up a small percentage of an average household's energy use. Others gladly accepted the free bulbs, but questioned the value of the credits that the new bulbs would earn. Many recipients reasoned that the bulbs were manufactured in China, whose economic expansion was being fuelled by Australian coal and other commodity exports that underpinned the visions of a competitive national economy held by both the conservative Liberal Party and Labor Party.

Researchers had long established that the efficiency gains from replacing incandescent bulbs with CFLs dwarfed the additional energy

required for manufacturing CFLs (see, e.g., Gydesen and Maimann, 1991). However, much simpler, physical and aesthetic considerations were causing me to doubt the veracity of laboratory studies and the technical measures of efficiency that they claimed. Many light fittings were designed for incandescent bulbs' slimmer surrounds and simply couldn't accommodate the fatter circuitry of the CFLs. Even where the bulbs did fit, factors other than their efficiency determined decision-making by householders. For example, many did not like the low Kelvin cool white colour temperature of our bulbs. My interest about the parameters chosen by regulators for the market in certificates was piqued by exposure to these factors, which were invisible to the abstract and instrumental metrics of carbon reduction governing the scheme. I began to wonder where the regulators were getting the numbers from to deem energy saved and create these credits.

If they were estimates – as I was beginning to think – what was going to happen to the certificates when household installation rates were audited? Moreover, I wondered who would take notice of such an audit – what sort of 'witnesses' to this experiment in greenhouse regulation would be necessary to address the scale of change to avoid the two degree rise in temperatures often cited as a likely 'tipping point' for catastrophic climate change (IPCC, 2007a).

Making markets real: situating the rise and fall of emissions trading

From the perspective of a worker in the industry, the frequent and often drastic regulatory decisions about these numbers gave the impression of a series of fragile full-scale regulatory experiments rather than a 'market' as I had conventionally understood the term. Could a carbon market only ever be a 'crude approximation of the real thing' (Berg, 2011)? Buyers and sellers of permits were mediated by government expertise to such a degree that the market-like flexibility of the scheme seemed to be diminished. I understood that deeming (estimating and thereby allowing upfront payment for) installation rates of light bulbs ultimately paid my wage. Simplifying the accounting process elided the variability of my installation experiences and created a profitable enterprise.

However, my job felt precarious due to the fragile status of residential and industrial greenhouse gas mitigation in the policy landscape. The degree of this fragility became evident when the announcement of an inquiry into emissions trading had the immediate effect of halving the price of certificates in the NSW market (Warren, 2007). The fall in price

reflected uncertainty as to whether the NSW scheme would either link into a series of state schemes should the Labor Party gain power in the coming 2007 Federal election, or be replaced by Howard's scheme.

Two elections later, the passage of a complex Federal carbon-pricing scheme by the Gillard Labor government has now been dismantled. The dominant conservative faction of the Liberal Party won the 2013 election campaign with a slogan of 'axing the carbon tax', conflating regulation through emissions trading with taxation in the public mind. Furthermore, powerful prime ministerial appointees have openly cast doubt on the veracity of the science of climate change,[2] which has led many to question whether *anyone* in the Liberal-National federal government associates global warming with the record-breaking heat, devastating 2009 Victorian bushfires, cyclone-flattened food crops and, ironically, flooded coal mines in 2011 in Queensland.

The vicious politics of emissions trading scheme design and implementation signals a complex relationship between discourses of environmental protection and economic ideas. The often-lively, encouraging conversations I had with customers keen to 'do their bit' (as long as it made economic sense) suggested to me that economic rationality alone was a poor explanation for accepting the efficient light bulbs. Discourses of participation, efficiency and environmental and economic 'win-win' were all evident in these conversations.

The narrow parameters of the light-bulb-substitution exercise instilled cynicism in many of my colleagues. If installing light bulbs alone really was a 'win-win', we wondered how the ledger for such victories was being drawn up and by whom. I had a strong sense that the acceptability of the scheme was tied to its superficial reliance upon instrumental and abstract outcomes far removed the decarbonization challenge that had motivated me to get involved. I was agitated in two ways by what was 'off limits' in our work. Firstly, the forms failed to account for the actual use of the lights, specifically whether or not they were being installed in empty or unused sockets. The nomination forms circumvented such issues as motivations and intentions by separating means from ends and making the policy amenable to different forms of measurement and quantification at a later date. This rationalization was a problem because we were hopeful the scheme would give rise to cuts in fossil-fuelled energy use in line with scenarios to reduce greenhouse gases in industrialized countries like Australia. Secondly, I was confronted with the enormous cost of logistics of the operation and time spent explaining the scheme to the householders simply to install the CFLs. We found it ironic that so many high-energy-consuming devices used in the households would

consume far more energy in a matter of weeks than would be 'saved' in the lifetime of these globes.

The pursuit of energy efficiency through changing lightbulbs seemed to be a Sisyphean task in the suburbs of Sydney. However, as a political experiment the NSW scheme presented the potential to pressure the federal government to implement policies to reduce greenhouse gas emissions. But I wondered whether a carbon market, like the one in which I was working, could ever provide a serious platform for more fundamental changes to Australia's electricity supply, transportation system and other sources of greenhouse gases whose effects I would see unfold in my lifetime. This book addresses that question by exploring the nature and operation of such markets and by contesting dominant accounts of the reasons for their successes and failures.

The writing of this book: methodology, use of sources, title and outline of argument

My experience with the NSW GGAS was a key motivation for formulating the initial research questions which have underpinned this book. The original research questions lay at the intersection of three problems. The first is that the planet could become uninhabitable if humans were to extract and burn all the known deposits of fossil fuels (Leggett, 2005). Consequently, how much extraction and burning is too much? Secondly, in the tradition of social-contract theorists, how can we, without resorting to violence, decide who burns this resource? The final problem relates to the place of price mechanisms in society and in government, an issue which has been something of a blind spot in the social sciences. My experience with emissions trading reinforced my sense that pricing mechanisms are central to modern life; yet our understanding of their culture and operations remains strangely underdeveloped. One reason for this shallowness explored in this book is the tremendous successes of the price *theory* promoted by the adherents of the Chicago school of economics. Whereas price mechanisms include legislation and institutions that enable markets to function effectively, the Chicago price theory is populated by utility-maximizing individuals calculating benefits regardless of the operations of market institutions (Davies, 2010).

My desire to better understand the two calculating worlds of economics and climate-change-mitigation policy has resulted in a book that moves between critical literatures on neo-liberalism, the technopolitics of scheme regulations and sociological accounts of their operation.

The experience with the NSW scheme piqued my curiosity about carbon-market construction as a practice of assembling devices to quantify carbon emissions. Could the seemingly mystical numbers about installation rates that my work relied upon really provide the basis of a new kind of institution and public – centred upon carbon market regulation? As I was considering these issues, Callon published his (2009) essay on the need to bring the learning of laboratory and real-world carbon markets together for effective carbon-market construction. Callon's (2009) essay provides the analytical point of departure for this book because he is an important figure in the study of markets and the development of Actor-Network Theory, otherwise known as the Sociology of Translation (Callon, 1986; Callon, 1998).

Translation means following the movement by scientists and other actors through and across the otherwise modern siloed institutions of economics, politics and science. Following this principle, I quickly found myself examining the technopolitics of biocarbon sinks – an accounting concept which refers to a drawdown of atmospheric carbon dioxide from the atmosphere to trees, other plants and soils over a specific time period. After extensive initial research on climate-policy history, I began to notice the pivotal role of carbon sinks in the United Nations negotiations and raised the issue with colleagues in the Centre for Energy and Environmental Markets (CEEM). One of them pointed out that Australia had pioneered forestry offsetting techniques, and that the first carbon trade was between NSW Forests and a Japanese power company. With NSW Forests eligible to generate plantation offset credits under the emissions trading scheme I had worked under, the seemingly arcane world of climate policy and my own unsettling experiences of emissions trading became connected in productive ways.

Discussions with colleagues led me to identify a number of key policy experts in the areas of biocarbon accounting, forestry management and land-use change monitoring. I set out a shortlist of questions about each person's involvement in various 'voluntary' and regulatory carbon-accounting schemes and conducted face-to-face or telephone interviews with them. A number of pressing questions on the construction of economic facts about trees (the threshold for many key national accounting 'offsets' under the Kyoto Protocol, as discussed in Chapter 4) arose in these initial interviews: How were highly imprecise satellite-borne remote-sensing technologies being used to 'frame' national biocarbon emissions and sequestrations? What other measurement and modelling techniques were necessary to fill in the 'gaps' between

satellite data and verifiable accounting? I posed such questions directly to subsequent interviewees and during some follow up interviews.

For answers to these questions, several interviewees directed me to the National Carbon Accounting System (NCAS) technical reports, a vital collection of secondary sources for chapters 3 and 4. These voluminous reports contain the methodologies for carbon-accounting models which underpin Australia's Kyoto accounts and, by extension, its targets for industrial-emissions mitigation policies. This book opens only a tiny fraction of the 'black boxes' (Latour, 1999) in Australia's carbon accounts, albeit consequential and contentious ones about land-use change and forestry measurement.

'Rise and fall'?

It is this modest spirit of opening black boxes that underpins the narrative of a 'rise and fall' of carbon emissions trading. The argument of a 'fall' in carbon pricing may seem quixotic given the proliferation of regimes in recent years – South Korea, Chongqing, Kazakhstan and California are among the 40 national and 20 sub-national jurisdictions that now carry the hopes of carbon-pricing proponents (World Bank and Ecofys, 2014). However, the notion of a rise and fall rather relates to a misplaced understanding of politics in conventional accounts of carbon trading. Politics always loomed large in my journey from light-bulb estimates to high-tech land-use monitoring and beyond. Much of this politics is easily identifiable as such, especially insofar as the imprimatur for the NSW scheme was to place pressure on the incumbent federal government. Beneath the veneer of objectivity and technical precision, disagreements about carbon-accounting interpretations were also political insofar as they relieved pressure on high-carbon industries to change their practices (see Chapter 4).

The heated arguments about highly consequential technicalities I document in this book suggest a more fundamental clash of knowledge regimes than appears in the orthodox, Whiggish accounts of carbon emissions trading (detailed in Chapter 2). In this account, measurement and calculation of carbon emissions is mobilized to reduce the space for dissent. Calculation cools heated arguments about economic trajectories and their associated forms of life (Callon, 1998; Callon, 2005). This cooling often occurs when standards are set to facilitate governing and trade (Higgins, 2005; Thévenot, 2009). Standardized objects, such as carbon offsets, can be traded when the terms of their measurement are agreed widely enough.

It is the sufficiency of this agreement that relates to the 'fall.' The political space for disagreement has fluctuated in ways that defy the narrative – that economics transcends politics – implicit in conventional accounts of carbon markets. Standards for measurement and accounting of carbon emissions and sequestrations have not simply stabilized over time (as Whiggish accounts implicitly presume). Thus, the rise of an interconnected global carbon emissions trading regime is premised on tenuous claims of efficiency that this book criticizes orthogonally, rather than directly. The 'fall' referred to in the above subtitle relates to the flip side of Callon's argument about calculation: in 'hot' situations, calculation does not cool conflicts, but inflames it further.

At a practical level, this book puts at stake the *prioritisation* of carbon pricing. If climate policy is a 'hot' situation, and this author suggests so, a range of regulatory instruments become necessary to decarbonize the economy without recourse to such large-scale calculation necessitated by carbon-pricing regimes. This is not a book of solutions; rather, the 'fall' in carbon emissions trading I refer to puts at stake the 'civilizing markets' thesis (detailed below) by arguing that distinctions between politics, markets and technoscience cannot be as easily identified as the thesis requires, let alone be revised. Carbon emissions trading schemes proliferate, yet they do so despite having fallen into a deeper, more opaque political chasm than its proponents recognize.

Outline of argument

Chapter 1 The Rise of Emissions Trading as a Market Mechanism: The promise of 'Civilized Markets' situates the project in a thorough review of existing accounts of emissions trading. Rather than assuming that emissions trading schemes were developed because economic theories were correct, this chapter instead outlines how emissions trading can be located as part of the machinery of liberal government. Building on the work of Donald MacKenzie and others, I apply the concept of 'materiality' to characterize the specific configurations found in hybrid regulatory-market schemes with tradable permits.

Chapter 2 Marketizing Civil Regulations: Acid rain regulation as the experimental 'bridge' to carbon markets. Here, I situate the distinction between 'command and control' (a rhetorical conflation of direct regulation with Soviet-era central planning) and a 'free market', upon which environmental economic theories are based. The chapter argues, not only that contemporary environmental economists such as Robert Stavins are, in fact, crucial experts for liberal governments, but that they have taken the mantle of premier civil experts from earlier civil

scientists – that is, they see themselves as accountable to industry, publics and governments. Stavinss' expertise rests on performing the opposition between 'command and control' regulation and a 'free market'; however, my analysis shows how civil regulations increase the reach of markets by providing new socio-technical boundaries that make externalities measurable, accountable and internalizable. My argument extends the work of MacKenzie (2009b), Voss (2014) and Lohmann (2006) by situating sulphur-permit trading firmly in the longer history of civil science and state regulation, rather than in Cold War–era ideology. My argument is that the political leverage exercised by environmental economists needs to be understood within the historical context of contestation between industry, government and civil science that stretches back to the early nineteenth century.

Chapter 3 Governing Carbon Emissions: Expertise, neo-liberalism and the politics of carbon offsets in New South Wales. This chapter participates in the debates about the ways emissions trading schemes are subject to a 'politics of testing' – a concept developed in science studies to argue that demonstrations of scientific facts are always inflected through social and political lenses. It provides an in-depth analysis of the first regulatory carbon-trading scheme in the world – the New South Wales Greenhouse Gas Abatement Scheme. I offer a number of significant insights about the role of testing and the importance of offsets in the building of alliances necessary to make the scheme politically palatable. A comparative analysis of forestry offsets and others shows that quantifiable, tradable units of emissions do not become tractable commodities through abstract measurement, but through practices of governing of life.

Chapter 4 The Politics of Carbon Accounting: Sovereignty, technology and scale. Timothy Mitchell suggests that climate-change politics is robust because atmospheric measurements have resisted challenge. In this chapter I argue that what sociologists of science have termed 'the interpretive flexibility' of land-use measurement remains an extremely powerful tool for industrial and state actors to assert their economic interests. This chapter critically engages with Callon's highly fruitful concept of 'framing'. I investigate the scalar politics of framing land-use changes by demonstrating how the imprecision with which trees are measured (by satellite remote sensing) proved to be of considerable economic and political consequence in the development of emissions trading in Australia and internationally; indeed a key clause of the Kyoto Protocol hinges on the factual status of land-clearing rates. What is at stake in land-use change accounting is not only economic

interests, as realist political economic analysis has long insisted, but also the accountability of climate fluxes according to the ideals of the United Nations.

Chapter 5 Economists in the Wild: The global politics of carbon offsets. This chapter applies the performativity thesis to the construction of the Clean Development Mechanism, drawing particular attention to the failures to 'civilize markets' by learning from the failures of its predecessor, Activities Implemented Jointly. The politics of contemporary environmental economists is made most explicit in this chapter, insofar as they (naively) seek to 'sever the Gordian Knot' and transform counterfactual economic measures into a science that transcends political discussion.

Chapter 6 The Paradox of Measurable Counterfactuals and the Fall of Emissions Trading draws together the central tensions in the case studies to critically assess the prospects for emissions trading. Paradoxically, around carbon emissions advanced liberal democracies have come to be governed by a complex and cumbersome set of economic *agencements* whose locus of power lies far from the efficient private bargaining promoted by Coase. Governance through markets has not replaced government by nation-states. Cumbersome markets in tradable permits have not come into being because of the efficiency of price mechanisms and the precision of science, but rather because of the political authority of economists at a peculiar moment in history.

Conclusion: Beyond 8% – Resituating emissions trading. I close by arguing that cumbersome, labyrinthine emissions trading schemes have become barriers to effective climate-change mitigation. Instead, grassroots initiatives with innovative governance through diverse socio-legal forms provide a more hopeful response to the world's climate crisis.

1
The Rise of Emissions Trading as a Market Mechanism and the Promise of 'Civilized Markets'

> 'It matters what stories tell stories, it matters what thoughts think thoughts, it matters what worlds world worlds'
>
> – Haraway, 2014

Who and what makes a difference to contemporary markets? The unnerving sense of collective disaster around crossing the two-degree Celsius 'guardrail' of global-warming emissions puts this question into stark relief: Can carbon markets save us by 'civilizing markets', as many hope, or are they part of the infrastructure that will hurtle us over the guardrail as critics have feared? The alluring promise of carbon pricing to civilize otherwise barbarically destructive tendencies in capitalism has achieved a near hegemonic status in climate-policy circles, leading to major experiments with carbon emissions trading schemes (ETS) at city, regional, national and international levels in places such as Australia, the European Union, New Zealand, and at the city level in Asia.

Claims that emissions trading schemes are suitable for all these jurisdictions and innately superior to other climate policy have relied upon strong rhetoric from economists. In its strongest form, economists claim that emissions trading won out over alternative regulations because its successes were self-evident. The federally appointed Australian expert, economist Ross Garnaut, best summarizes the victory of emissions trading:

> There was for a while in the twentieth century a great contest of ideas, about whether market-based or regulatory approaches to managing the economy were more conducive to economic welfare.

> The regulatory approach went under the name of 'central planning'. The case for regulation depended on assessments of high transactions costs and instability in the market economy, on the capacity of Government to take a wide range of decisions more reliably than individual economic actors, and on the capacity of Governments to secure intended outcomes when they intervene directly to replace private by official decisions. That contest of ideas was won decisively by the market economy. It was not won in theory. It was won by observing the results of predominantly market-based decisions and predominantly regulatory interventions.[1]

This is not a book against carbon pricing, but rather a story about its origins, capacities and possible worlds, a story different to the one put forward by Garnaut and other neoclassical economists. As Richard Lane has forcefully argued, 'this understanding of the "laws" of efficiency – emissions trading as efficient, and of command-and-control regulation as inefficient – is wrong. It is wrong because it simply takes these as given, as facts that were settled "behind the scene, above our heads and before the action"' (Lane, 2012: 584). Far from a popular mythology of facts being supposedly translated by scientific evaluation into economic policy, economists have made markets in close negotiation with policymakers through establishing bureaucratic agencies, measurement devices and new accounting methods that align with a liberal world view. Garnaut's claims about the supremacy of regulatory emissions trading schemes over taxes and more direct regulation are one of many claims by governing actors – from entrepreneurs to economists and regulators.

The development of tradable permits and offsets are one way to stake a claim: that you are making a difference by redrawing the line between 'business as usual' and some imagined other future. Capitalism and markets only attain their identities in contrast to the non-capitalist or the non-market (Mitchell, 2002: 245), as with Garnaut's sharp distinction between markets and 'the regulatory approach' of 'central planning'. The difficulty with emissions trading schemes so far has been establishing an identity *as a market* separate from taxation and regulation whilst also requiring the resources of regulators and the authority of law.

Emissions trading schemes have failed to respect any clean boundaries in economists' designs. Cap-and-trade schemes have invariably included carbon offsets, whilst fixed pricing mechanisms have blurred the boundaries between trading and taxation – a vexing point for participants in

debates about carbon pricing in Australia, where an introductory fixed price was legislated to give way to a floating price[2] (Bailey et al., 2012). In fact, Google searches for 'carbon tax' eclipsed the analogous searches of 'emissions trading', 'carbon market' or 'carbon trading' in 2011[3] at the height of Australia's climate policy debate.

Such pervasive linkages between law and price blur Garnaut's sharp distinction between carbon markets and 'command and control' in practice. And, yet, neoclassical economists remain ever faithful to the power of prices, arguing that if the costs of carbon emissions can be fully internalized by companies, the problem of climate change would be solved. Here, parsimony is the objective, as exemplified by Massachusetts Institute of Technology (MIT) economists Henry Jacoby and John Reilly in their 'one page plan to fix global warming'. In drawing attention to what is marginalized and ignored by pricing regimes, this book is a plea to move beyond the neo-liberal impulses that underpin comments such as: 'Getting the price right…is a key principle of a carbon pricing instrument' (World Bank and Ecofys, 2014: 33), and '[W]hat's needed is a carbon price, period'.[4] These comments suggest a world in which the signifier of price reigns over all others, perhaps expressing an anxiety that imagining the end of capitalism could be easier than imagining the end of the world.

Empirical and critical analyses of emissions trading

This chapter lays out the framework of analysis by first providing a brief empirical assessment of emissions schemes' effectiveness to date and then by providing an overview of critical perspectives on emissions trading before laying out my own framework of analysis drawing from the performative turn in economic sociology, from assemblage thinking and from governmentality studies. My aim with this framework is to put the 'histories of capital in conversation with human histories' (Chakrabarty, 2009) by examining the co-constitution of resource-extraction and modern political institutions in ways that recognize nonhuman agency. As Jo Guldi and David Armitage state in their call for a return to *long duree* thinking:

> the major abstract concerns of climate scientists and the policy specialists who responded to them were questions over periodization, events, and causality; they were problems in the philosophy of history.… We are in a world that more and more looks to history to make sense of the changing nature of world events. But what if

> protecting the planet requires rejecting prosperity? That line of thinking would require a very different theoretical toolset than the one that currently dominates corporations and policy. Moreover, a true sustainability will involve unthinking the power of terms like 'improvement', 'development', and 'growth', which modern capitalism has inherited from the last two centuries of its historic development, and which are embedded in all economists' definitions of success with knowledge of these events, institutions, and discourses, however, the possible future of action becomes wider again. These stories are therefore vital for our time; they illustrate how important narrative history is for clear thinking about the future. They also raise important questions about the kind of story-telling that we most need right now. (Guldi and Armitage, 2014: 33)

The rise and fall of carbon emissions trading documented in this book seeks to move beyond the obsession with price in a climate-policy debate. Much of the literature – academic economics papers, NGOs', consultancy and government reports – advocating carbon emissions trading either ignores or sidelines the empirical assessment of the emissions trading scheme's effectiveness. The fetish of price is most pronounced in reports by the 'Carbon Disclosure Project' carried out by a not-for-profit industry body 'providing the only global system for companies and cities to measure, disclose, manage and share vital environmental information [working with] market forces to motivate companies to disclose their impacts on the environment and natural resources and take action to reduce them'.[5] CDP reports provide information about internal carbon prices used by companies and which are mostly employed to identify inefficiencies – collapsing sustainability justifications for pricing carbon with competitiveness ones (Nyberg and Wright, 2012).

The World Bank's (2014) *State of the Carbon Market* reports, which have been published annually since 2007, also focus on abstractions: quantities of permits bought and sold, sectoral coverage of schemes, linkage rules and other minutiae. Simple percentage assessments of emissions reduced against some baseline are surprisingly difficult to find – and this is largely because they rely on counterfactual assessments. Few are willing to quantify 'what would have happened otherwise'. The impossibility of economic prediction is often the excuse for advocating a carbon tax instead of trading (Wara, 2014), or for treating *ex post* evaluations with a great deal of scepticism (Tietenberg, 2006).

Studies of the effectiveness carbon emissions trading show modest reductions to date. The first phase of the EU emissions trading scheme resulted in an estimated 8 per cent reduction (Ellerman and Buchner, 2008). The second phase reduction was 2–4 per cent larger because they coincided with the global financial crisis. Meta-analysis of top-down and bottom-up studies found 'some early evidence of a small but non-trivial impact on emissions abatement' (Laing et al., 2013). Windfall profits have amounted to billions of euros, and carbon prices were passed through in electricity, diesel and other sectors where limited technologies changes were recorded (Laing et al., 2014). The New Zealand Environment minister anticipated the country's emissions trading scheme to result in a 1 per cent reduction from business as usual projections (Bullock, 2012). During the scheme's short lifespan, Australia's carbon price led to a 1 per cent fall in national emissions, with electricity sector emissions falling 8 per cent before being repealed by the conservative Abbott government in July 2014.

The public death of emissions trading schemes through an election is the most spectacular way for a scheme to end, but this has been the exception rather than the rule. New allowances simply cannot be issued once a fixed period over which reductions are scheduled to take place has ended. This occurred with British Petroleum's internal scheme where planned business never materialized and so no new caps were announced. Having met lax targets, the scheme was shelved (Victor and House, 2006). The Chicago Climate Exchange followed a similar trajectory, collapsing as businesses pledged voluntary reduction commitments to 2010, but no further (Reyes, 2014: 6). The UK emissions trading scheme followed a trajectory similar to the NSW GGAS scheme analysed in Chapter 3. This scheme was dominated by a small number of large players who made simple modifications to their industrial practices, thereby allowing lax emissions caps to be met as cheap credits flooded the market (Reyes, 2014: 6).

Longstanding carbon taxes seem to offer some solace, showing sustained reductions in European nations such as Norway, the Netherlands and Sweden (Withana et al., 2013). However, another set of literature using such concepts as 'carbon leakage' or the 'Jevons Paradox' calls their effectiveness into question. Research collating emissions data internationally shows that rich nations are effectively outsourcing their emissions to the developing world, where carbon-intensive manufacturing has been relocated during this same period (Hertwich and Peters, 2009). Global emissions even rose significantly during the recent financial crisis (Peters et al., 2013).

Critical literature centred on the development of carbon emissions' trading schemes has burgeoned in recent years, and it can be grouped according to three main sets of arguments (see also Table 1 below):

(1) Economist advocates such as Garnaut (2008), Stavins and his colleagues (2010; 2010; 2012) and Tietenberg (2006; 2013), who argue that neoclassical price theory is superior to all other regulations and that failures in carbon markets have been impeded by law and government. This argument relies on a linear theory by which pricing concepts have been tested and proven (Voss, 2007; Voss and Simons, 2014).
(2) Opponents of carbon markets who argue that they do not work because the theories that underpin them are wrong and the interests they serve are undesirable. Lohmann (2006) exemplifies this.
(3) 'Performative' moderates, such as Callon (2009), who argue that 'matters of concern' must be accommodated in the design and revision of carbon markets during periodic assessments for them to work. This approach implicitly seeks to move beyond what Gibson–Graham (2006) term capitalocentrism: the hegemonic representation of all economic activities in terms of their relationship to capital.

Opponents of carbon markets argue that they are founded upon 'fictional commodities' (Lohmann, 2006; 2010). The concept of 'fictional commodities' was first introduced by the 'father' of the substantivist social science, Karl Polanyi ([1944] 2002) to refer to the ways land, labour, and money are created by the market to allow for its very own existence. Lohmann's (2010: 12) critical outline of the process of carbon marketization centres on commodification:

> Step 1: The goal of overcoming fossil fuel dependence by entrenching a new historical pathway is changed into the goal of placing progressive numerical limits on emissions (cap).
>
> Step 2: A large pool of 'equivalent' emissions reductions is created through regulatory means by abstracting from place, technology, history and gas type, making a liquid market and various cost savings possible (cap and trade).
>
> Step 3: Further tradable emissions reductions 'equivalents' are invented through special compensatory projects, usually in regions not covered by any cap, and added to the commodity pool for additional liquidity and corporate cost savings (offsets).

> Step 4: Project bundling, securitization, financial regulation, 'programmatic offsets' and so forth provide further help in making 'reductions/offsets' into a speculative asset class.

This book takes a different approach, charting how the real and fictional are performed in the making of carbon offsets by translating such things as photographs, measurement devices, economic models, accounts and a range of heterogeneous elements to make socio-material networks in which numbers appear objective and transparent.

The emphasis I place on performativity highlights the importance of differentiating between forms of carbon markets, something that critiques policies using tradable permits often fail to do (e.g., FoE, 2009). Performativity, with its emphasis on process, can therefore be distinguished from substantivist accounts anchored in the representation of economic actors and institutions. Throughout this book, Larry Lohmann's work is outlined as exemplary of this representationalist perspective, by counterposing 'fictitious' commodities with 'real' communities.

Whilst Callon understands economics as a facilitator within a network, Lohmann's accusation that carbon offsets are both morally wrong and a 'fictitious commodity' disavows this experimental ideal. A performative perspective, however, does not respect the boundaries of real and fictional, of objects and ideas, of nature and culture and of representation and reality (Mitchell, 2002; Mitchell, 2014) but, rather, argues that economics builds worlds in its own image of rationality and efficiency. These worlds are not superimposed upon already-existing social relations, but reconfigures them in a politics of market design that neoclassical economists guard fiercely. The ambition of re-grounding environmental economics from its lofty claims of rationality to a more modest and situated practice lies at heart this approach (Blok, 2011).

All three groups of arguments about emissions trading outlined above share a common narrative and a number of common assumptions about its origins. Voss (2007; 2014) and MacKenzie (2009b) analyse how economists have made models of firm behaviour related to emissions trading 'more realistic' by shaping trading schemes to prevalent institutional constraints and available technologies, such as sulphur emissions monitoring systems. Voss (2007; 2014), MacKenzie (2009b) and Lohmann (2006) all situate the emergence of emissions trading in a number of developments. Firstly, its emergence is placed in the context of Coase's (1960) work on the conditions under which bargaining between actors is considered efficient. Secondly, it is shown to relate to the way this neo-liberal programme was translated into a variant of transaction-cost

economics[6] concerning, primarily, air and water pollution.[7] Thirdly, in the 1970s and 1980s a number of small and largely 'ham-fisted' experiments with trading pollution between firms were conducted in the United States to demonstrate Coase's theories (MacKenzie, 2009a: 442). Finally, the studies of the vast majority of US environmental economists, as well as Voss (2007; 2014), MacKenzie (2009b) and Lohmann (2006) stress the importance of the US acid rain scheme as an experimental bridge or prototype between these earlier studies and current carbon emissions trading schemes.[8]

Despite sharing common assumptions about the origins and trajectory of emissions trading, Lohmann's, Voss's, and MacKenzie's accounts deploy distinctive frameworks to interpret emissions trading, whose main fault lines are sketched in Table 1.[9]

By studying economic exchange in the making, the performativity programme seeks to overcome the deeply entrenched divide between formalist and substantivist economic schools of thought (Callon and Çalkan, 2009; Callon and Çalkan, 2010). Nevertheless, the programme overlaps with some of the concerns of transaction cost economics.[10] Both share the assumption that markets are imperfect devices and economic action and cognition are bounded by a range of factors. However, the

Table 1.1 Critical perspectives on emissions trading analysed in this book

Grouping of arguments	Stance on carbon emissions trading	Main progenitors	Narrative of how emissions trading developed	Economic tradition
'Environmental Economics'	Superiority has been demonstrated, though impeded by politics, law and bureaucracy. Pricing needed above all else	Stavins, Tietenberg, Hahn, Garnaut, Voss	'Linear' testing through innovative phases	Formalist
'Critical Left'	Schemes have failed and serve corporate, not public, interests. Unsuitable.	Lohmann, Reyes	Successive phases of exploitation for corporate gain	Substantivist
'Performative'	May work if the right 'matters of concern' are accommodated by the broad actors involved in governing. One suitable tool among others.	MacKenzie, Callon	Successive material assembly of regulatory markets	Markets are socio-material assemblies.

'performativity' programme ostensibly diverges from economists' implicit view of history, instead understanding the trajectory of emissions trading, from theory to implementation, as being outside the 'linear' narrative of economists[11] (MacKenzie, 2009b). Just as natural scientists did not 'discover' nature, economists did not 'discover' the conditions under which private economic actors become more efficient than public ones (MacKenzie, 2009b: 32). Economists are one source of innovation in environmental regulation, but legal structures, professional accounting bodies and civil expert actors also contribute to the pioneering, testing and development of emissions trading schemes.

Callon's (2009) civilizing markets thesis centres on experimentation. He seeks to reconceive carbon emissions trading as a platform by which to link different scales of economic experimentation with the imperative to curtail carbon emissions. Crucially, scale refers to the size of the experiment and its level of abstraction, with a scale of 1 referring to the largest-size experiment. Callon buys the neoclassical argument that carbon markets could be a cost-effective alternative to technological standards or more direct measures, such as bans on fossil-fuel extraction and use. Central to Callon's proposal are two pairs of concepts: firstly, *in vivo* and *in vitro* experimentation; and, secondly, framing and overflows. The first of these pairs concerns Callon's understanding of economics as a facilitator of activity at large in society, rather than a more or less accurate representation of institutions or processes, while the second of them concerns the socio-material basis and consequences of economic calculation.

Callon (2009) borrows a metaphor from the life sciences to distinguish scales of economic experiments: those run *in vitro* (on a laboratory scale) and those run *in vivo* (on a 'full' scale). *In vitro* and *in vivo* scales of experimentation are defined by their degree of openness or confinement rather than by their 'reality' or their capacity for producing results that are able to be scaled up for use (Callon and Muniesa, 2005: 167). The distinction between these two forms does not mean that *in vitro* experiments are less 'real' than *in vivo* experiments; both have real incentives, take place in real institutions, and have real payoffs (Callon and Muniesa, 2005). This method distinguishes Callon's approach from the linear model of technology development used by Voss (2007) and focuses instead on mechanisms of market design and revision.

Callon views all markets as requiring some degree of construction.[12] Markets are socio-technical *agencements*: 'combinations of material and technical devices, texts, algorithms, rules, and human beings with their various instruments and prostheses'.[13] The concept of an *agencement* is a play on the words 'arrangement' and 'agency'. In everyday

French, 'arrangement' refers to the physical parts of a machine, while the expression '*bien agence'* means to be well equipped (MacKenzie 2009b: 19–22). '*Agencements* denote socio-technical arrangements when they are considered from the point of view of their capacity to act and give meaning to action' (Callon and Muniesa 2005, 24–25). Emissions trading schemes are *agencements* because 'what is designed, tested and evaluated combines material, textual and procedural elements' at both laboratory and *in vivo* levels (Callon 2009: 537).

The generalization of experimental results is not related to scale, but, essentially, to a 'question of site' (Muniesa and Callon 2007: 165). The role of economists and other actors in specifying, circumscribing, contesting and extrapolating from the site of experimentation is therefore crucial. Actors are invariably excluded in these movements across sites. For emissions trading:

> Unexpected actors, orphan or affected groups ... appear when no one was expecting them, for the good reason that they could hardly have existed as groups considering themselves to be concerned by the functioning of carbon markets before those markets were established. (Callon, 2009: 540)

Callon's 'performative' concepts of experimentation, framing and overflows are a touchstone for this book for two main reasons. Firstly, carbon emissions trading schemes are now at a critical phase in the evolution of climate policy. Successes are modest, and many concerns about both the substance of schemes and the context of climate policy have arisen (to which the following chapters add a limited list). California and Guangdong are now key players in developing carbon markets, whilst the EU struggles to maintain even basic credibility in its ETS (Grubb, 2014). The global political fault lines have changed profoundly from the distributions specified in the United Nations Framework Convention on Climate Change's (UNFCCC) annexes some 25 years ago. Brazil, China and South Africa are now major emitters, a fact that reactionary counter-movements to ambitious climate policies in countries like Australia have seized upon as further grounds for delaying and cancelling policies to curb greenhouse pollution.

Secondly, concepts of experimentation and performativity also have normative dimensions: to take seriously the concerns of affected groups who may not initially be qualified as experts. Here, Callon's expertise in public engagement with science and technology (Callon et al., 2009) is a key element sorely lacking in much climate policy. His call to civilize

markets (Callon, 2009) is actually only a minor paper in Callon's body of work, with some 188 citations recorded on Google Scholar by October 2014, and his only foray into climate policy. Revising expert/non-expert boundaries requires design and governance arrangements that specify how trading rules can be periodically revised.[14] That is, emissions trading can 'civilize markets', provided economic experimentation is effectively linked to both scheme design and the social groups concerned with the operation of markets.

Understanding economic meaning as an assembly of socio-material devices also raises problems of limitations and constraints. The work of Hatherly et al. (2008) on 'finitism', applied to emissions trading by MacKenzie (2009b), draws attention to how creating facts in accounting is constrained by a variety of factors: technical, cognitive, embodied, material and social. According to a finitist analysis, entities like a 'human-made' plantation – which may, for example, earn afforestation offsets in an emissions trading scheme – do not exist to be described and classified. Rather, they are created according to a finite number of past instances; hence 'finitism'. As MacKenzie argues, 'every situation is in detail different from every other' (MacKenzie, 2009b: 26). A finitist analysis of carbon accounting suggests that 'we create meaning as we move from case to case' (Bloor quoted in MacKenzie, 2009b: 31).

Though finitism and Callon's approach both illuminate the contingent nature of economic calculability, they do so in different ways. Callon's approach (Callon, 2007b:.318–319) refers to the discursive conditions under which statements about singular events frame socio-material *agencements* that are then adjusted and calibrated accordingly. A finitist approach, however, draws attention to the implicit judgements in the work of accounting. One crucial set of judgements this book addresses concerns the distinction between human and natural carbon sequestration operationalized in national accounting.

The significance of finitism, and its complementarity to Callon's approach, is further illuminated through a contrast with 'extensional semantics', which is directly opposed to finitism. Extensional semantics assumes, for example, that deforestation can be prevented by improving definitions, measurement and the monitoring of carbon fluxes. One form of 'extensional semantics', common in economics, is the rationalist approach exemplified by US economist William Nordhaus's work (Nordhaus, 1991; Nordhaus and Boyer, 1999). This approach is rationalist because it treats the entire climate policy problem as one amenable to optimal calculation and fails to consider the work of translation across institutional domains. Nordhaus's Dynamic Integration of

Climate and Economy (DICE) model, first presented in 1990, sought to project the costs of various mitigation options combining general equilibrium economic models with climate models to 'weigh the costs and benefits of taking steps to slow greenhouse warming' (Nordhaus and Boyer, 1999: 6). By the end of the 1990s, there were more models than Nordhaus himself could keep track of (Nordhaus and Boyer 1999b, 8). These models[15] provide valuable tools for policymakers by setting as a reference point 'the economist's dream of an "efficient' policy"' (Nordhaus and Boyer, 1999: 6). For Nordhaus, models are powerful decision-making tools because they provide a rationale for policymakers to 'better understand the complex trade-offs involved in climate-change policy' (Nordhaus and Boyer, 1999: 6).

This rational approach of trade-offs can be compared with a performative approach:

> What the performativity thesis does add is that there is no one best way, no single form of organization that imposes itself naturally and compellingly, so to speak, able to ensure the optimal functioning of markets. Markets, to stick to this very specific economic form of organization, are complex realities that can be configured differently, with each configuration designed to respond to particular orientations and requirements. (Callon, 2010: 163)

This elaboration of the performativity thesis, therefore, draws attention to the devices and sites of carbon market design, while highlighting the contingency and constructedness of expert authority upon which such design relies. In the context of natural resource management, the creation of precisely controlled, qualified, standardized units creates a surer basis for their commodification.[16] Government agencies have emerged to systematically assess and evaluate economic activities, thereby expanding the scope of trade by qualifying and grading goods and thereby allowing market segmentation to occur (Mallard, 1998). Carbon markets extend this socio-technical dynamic of valuing and measuring, shifting the boundaries between the inside and outside of what is measured, evaluated and accounted for by those affected.

Emissions trading as an extension of liberal governmentality

Whereas the performativity programme has been directed to documenting the rich minutiae of markets, governmentality scholars have

examined *how* economic concepts and programmes have been constituted as vectors of power. Carbon emissions trading relies both on measurement of carbon dioxide emission equivalents and expert authority necessary to legitimate the quantification of counterfactual savings through economic modelling. Foucault's (2003; 2008) work on neoliberalism investigated the historical relationships between price and political power by drawing attention to limitations with incumbent conceptualizations of power as articulated within the 'juridical model of sovereignty'. According to this model, power is backed by the threat of violence (as in the police force to enforce contracts) or embodied in mechanisms to generate agreement (such as voting). However, for Foucault, we must not look 'for the single point from which all forms of power derive, either by way of consequence or development', but instead examine their 'multiplicity, their differences, their specificity, and their reversibility' (Foucault, 2003: 265).

Thus Foucault displaced the concept of the state with historically situated ways of *thinking* about technologies of government together with political rationalities (Lemke, 2002). In this book, I use the concept of governmentality to expand Callon's ideas of performativity – politically and historically. Governmentalities are ways of thinking about how governing relates to the empirical terrain of material inscriptions, rationalities, technologies, programmes and identities of government. The relationship between materiality, thought and action is not wholly reducible to this terrain, because it is also about the production of concepts, such as 'economic growth' (Dean, 2007).[17]

A governmentality analysis of emissions trading highlights the shortcomings of the approaches used by Lohmann by historically situating liberal thought as not just a mechanism to restrain state power through economic measures, but as one to govern social rationalities and actions. In 'critical left' and 'performative' accounts of emissions trading, context is either all-encompassing (the world-historical epoch of neo-liberal capitalism in Lohmann's account) or neglected at the expense of following economists' statements themselves (as in MacKenzie's account).[18] The reading of governmentality pursued in this book aims for a more nuanced historical understanding of materiality and context.

Although my book is not an analysis of such subjects,[19] the genealogies of liberal thought undertaken by governmentality scholars are relevant in three ways: they have critically documented the rise of neo-liberal economic ideas as programmes to manage the economic life of populations; and they have potently shown historical breaks

in the relationship between market and state and between liberal and neo-liberal arrangements of governing *(dispositifs)*. Firstly, they provide valuable insights into the translation of Ronald Coase's seminal work into a theory of markets and policies for state action. As Lohmann emphasizes, Coase's central achievement was to *redefine* externalities as a problem of property rights.[20] For neo-liberals, including Coase, micro-economics provided a framework for governmental decision-making – a framework that could act as a filter for the inconsistency of competing demands for regulating the market price of electricity and other commodities. Prices are the most rational means of maximizing the utility of individuals; markets, however, are assumed to be imperfect and to incur 'transaction costs'.

Secondly, emissions trading schemes share with the neo-liberal 'law and economics' movement the objective of displacing legal and moral views of 'right' and 'wrong' with *a priori* incentives and measured outcomes (Davies, 2010). Governmentality scholars point out that where classical liberals use the state to discipline the market, neo-liberals – building on Coase's critique of taxation – developed emissions trading and other market-like measures to demarcate the limits of state actions (Foucault, 2008). Deviance from the technical goal of utility maximization is regarded as a distortion from optimality: law and politics recast as transaction costs. This highly mechanistic view of the very institutions that make exchange possible permeates economists' defences of global carbon pricing as the central tool of climate policy. As Tom Tietenberg states, 'A number of constraints can operate on emissions trading programmes. These arise from statutes, court decisions, or simply the implementation of rules that flow from the bureaucracy' (Tietenburg, 2012: 33).

Thirdly, much contemporary usage of the term neo-liberalism tends to overstate its coherence as a political project. Usually this means conflating multiple projects, processes or institutions, such as eliding the distinctions between markets and capitalism. In Foucault's analysis, liberalism is neither theory nor ideology but, rather, a practice with many variants. Another variant, ordo-liberalism, emerged from post–World War II Germany and involved outlining explicit roles for the state in not only correcting market failures but also promoting a strong vision of a free, competitive economic order (Foucault, 2008). Visions of a 'social market economy', the ideas of which can be traced to the work of Max Weber, were strongly promoted by German members of the Mont-Pelerin Society (Davies, 2009a; Ptak, 2009), who were key players in developing this view of economy and society.

In Max Weber's (Weber, 1971: 181) seminal account, the ascetic drive of capitalism constituted a domineering force

> bound to the technical and economic conditions of machine production which today determine the lives of all the individuals who are born into this mechanism, not only those directly concerned with economic acquisition, with irresistible force. Perhaps it will so determine them until the last ton of fossilized coal is burnt.

For the Puritan Richard Baxter, 'the care for external goods should only lie on the shoulders of the "saint like a light cloak, which can be thrown aside at any moment". But fate decreed that the cloak should become an iron cage' (Weber, 1971: 181). Ordo-liberals articulated a regime that would resist this cage by departing from the natural-rights discourses of classical liberalism. Instead, the social order would be created through the *eidos* – the cultural form, rather than naturally given form – of the market. The market was not only to be an outcome of individual interests through competition but was itself to be desired by individuals (Goldschmidt and Rauchenschwandtner, 2007). The ordo-liberal lineage is most prominent in contemporary climate-policy work through Dieter Helm's endeavours. Helm articulates a role for the state in fostering conditions for an efficient use of carbon permits, thereby purportedly avoiding 'regulatory capture' and 'pork barrelling', terms describing anti-competitive and corrupt actions (Helm, 2010) Here, the state is not simply something to be brought under the purview of the market and criticized for its relative inefficiency, but must be clearly and forcefully delineated through laws and policies (Helm, 2006; Helm, 2008).

The neo-liberal elements of emissions trading and the ordo-liberal issues of competition present two discourses of state power. Emissions trading schemes are thus caught between condemning cumbersome bureaucracy (compared with markets, per Coase), and the need to articulate a role for such a bureaucracy in ensuring markets function effectively. This is just one aspect of the 'paradox of measurable counterfactuals' this book illuminates as a route into the history of economic thought as 'a history of the constant addition of protective layers to render it more and more impossible for intruders (read politicians and ordinary people) to meddle' (Latour, 2014: 5).

In summary, then, the ambition of this book is less to convince economists that their models are wrong than to situate them historically. History is not about abstract description, but performs economic ideas such as the demonstrated superiority of carbon pricing over other

regulations. For critics, such demonstrations signify a universal narrative of capital against which counter-narratives must be assembled. However, performative and historical accounts offer a different avenue of inquiry, instead illuminating the movement from sites of experimentation and abstraction to produce something called a 'global' tradable carbon unit. Returning to Haraway's quote at the beginning of the chapter, performative accounts do not aim at unmasking the neo-liberalism of the global so much as showing the promiscuity of economic world-making, asking what other connections we may think to 'world other worlds' – that is, imagine and perform economic activity in ways that recognize and sidestep the pathologies of neo-liberalism. The next chapter builds on the critical accounts of neo-liberalism outlined above to argue that Coase and his colleagues actually sought to place 'environmental economics', as the preeminent source of civil scientific knowledge, above ecological disciplines.

2

Marketizing Civil Regulation: Acid Rain Regulation as the Experimental Bridge to Carbon Markets

The conventional history of emissions trading underpinning debate about carbon emissions trading begins in the 1960s with American attacks on inflexible, 'command and control' regulations. This chapter challenges this reading of regulatory history, placing these developments in a longer history of pollution control whereby law and science interact to shift problems created by industry. A crucial change from the nineteenth-century to twentieth-century regimes of acid regulation was the shift in prominence from civil society and associated experts using moral language, on the one hand, to economic expertise claiming to operate on the basis of efficiency, on the other. This was not a shift from 'command and control' to markets, but rather one form of governmentality to another in the sense that cost began to figure increasingly in rationales for government action.

This chapter follows the development of increasingly complex and cumbersome sulphur-pollution control regimes in Europe and the United States. A comparative perspective shows how relations between the economically calculated (something that pre-occupies neo-liberal economists) and its exterior are managed according to cultural, technological and historical factors, rather than simply expressing more or less efficient forms of calculation. I argue that the European regime was more *civilized,* in the sense understood by Callon, as having developed institutions to reposition the distinctions between the scientific, economic and political components of emissions control. This is not to argue that the US pollution-control regime was more or

less efficient or rational because it was based on a market approach. Studies attempting to compare the regulations have highlighted the incommensurability of the two regimes from an economic-efficiency standpoint (Watkiss et al., 2004). Nor is it to argue that the US sulphur permit regime was less real and more socially constructed than the European regime.

The chapter is divided into five sections. The first provides analysis of a crucial actor in liberal government: the civil scientific expert. This figure juggles independence with accountability to elected officials, industry and the public. The work of Robert Angus Smith provides an historical reference point for the significance of neo-liberal economic theories of efficiency that promise to bring the regulations of civil science under the objective scrutiny of price theory. Smith helped grasp and make economically calculable what *laissez faire* institutions and processes could not: the acidic emissions of the nineteenth-century chemical industries. The guiding concept for this analysis is the concept of nuisance, which developed important regulatory connotations due to these emissions. Smith established a role as expert by not only seeking to demonstrate causal relationships between sources and receptors of pollution but also by recourse to metaphysical concepts, such as the 'evil of pollution'. The significance of these distinctions was not only in the social categories of expertise, morality and pollution, but in the regulatory *agencement* which formed around measuring, framing and restraining acidic discharges from industry.

The second section examines how, by the 1950s, public health experts in Europe and North America sought to justify governmental regulation in secular, technical terms. Regulators sought to develop objective, numerically based regulations for pollution sources on the basis of projected mortal pollution events, which meant pitting their authority against the socio-economic rationality of electricity generation. The subsequent regulatory stoush brought about the problem of trans-boundary acid rain, as emissions from the burning of highly sulphurous coal for electricity were moved away from growing urban centres through technical fixes such as the utilization of higher emission stacks.

The third and fourth sections document the subsequent European and American responses to the acid-rain problem, highlighting the commonalities in the role of economic expertise and comparing how the uncertainties of economic models were utilized and negotiated. The European response saw the creation of the world's first trans-boundary air pollution treaty and required the installation of source-control technologies. The American response was the prototype of emissions trading: the

Sulphur Permit Trading Scheme under Title IV of the 1990 Clean Air Act Amendments (CAAA).

The fifth section analyses the outcomes of the trading scheme and questions narratives of technological innovation implied by neo-liberal accounts of the scheme. The role of a range of compliance strategies, especially freight rail de-unionization and deregulation, are evaluated and are compared with economic assessments that posit the price mechanism of permits as the primary causal factor in maintaining the lower-than-expected cost of the scheme. The chapter concludes with analysis of what is at stake in economists' narratives of the causal role of price.

Nuisance: the liberal foundations of environmental regulation

Acid deposition and global warming are both a product of modern fossil-fuel combustion emissions. Modern industrial chemical production processes have also emitted a considerable amount of acidic and global-warming gases. The connection between acid-damaged buildings, flora and fauna and the combustion of highly sulphurous coal was established in Britain during the early 1800s. In cities like Manchester, coal was burned to fuel homes and businesses, resulting in acidic depositions on buildings and thick smoke in the lungs of residents. Industrial hubs in South-East Lancashire and Tyneside producing glass, soap, and textiles sent thick clouds of muriatic[1] acid into the verdant countryside, transforming green fields into grey wastelands (Dingle, 1982: 530). One observer noted:

> The sturdy hawthorne makes an attempt to look gay every spring; but its leaves ... dry up like tea leaves and soon drop off. The farmer may sow if he pleases, but he will only reap a crop of straw. Cattle will not fatten ... and sheep throw their lambs. Cows, too, ... cast their calves; and the human animals suffer from smarting eyes, disagreeable sensations in the throat, and irritating cough, and difficulty of breathing. (quoted in MacLeod, 1965: 87)

Common-law institutions were unable to rectify this 'intolerable'[2] situation because the collective emissions from industrial hubs could not be precisely tracked from recipients' properties to the source (McLaren, 1983). As a common-law jurisdiction, torts had been the primary avenue for rectifying non-contractual disputes where private property was damaged. Until the mid-1850s, rural and agricultural land uses

tended to be favoured in common-law judgements (McLaren, 1983). During the 1850s and 1860s, however, failed torts by farmers and upper-class residents downwind of industrial facilities suggested that a certain level of 'nuisance' had become recognized as the price of progress (McLaren, 1983).

The concept of 'nuisance' constituted a malleable boundary that enabled industries that contributed to the problem of acidic emissions to continue expanding under civil regulations. Definitions of tolerable harm to population, flora and fauna were interpreted differently by residents and experts. 'Nuisance' indicated an experiential threshold of modern industrial progress, leading to the creation of the oldest pollution regulation institution in any liberal democracy. For over a century[3] – from the passage of the 1874 Alkali Act – the chief inspector (with the assistance of an increasing number of sub-inspectors) applied standards to large industrial emissions within a statutory framework with considerable administrative discretion to negotiate and enforce pollution levels (Hill, 1982). By the beginning of the twentieth century, the Alkali Inspectorate had consolidated into a national regulatory agency responsible for monitoring industrial pollution (MacLeod, 1965; Hill, 1982; Dingle, 1982; Garwood, 2004).

What is significant for this chapter about the problem of acidic emissions is the way metaphysical and moral concepts of pollution were connected by civil scientists to rational, causal, techno-scientific ideas. Neo-liberal environmental economists would later promise a more rational basis of government than civil scientists by bringing social and legal decisions under the purview of economic measurement. Crucially, as we will see in Chapter 6, this promise still relied upon immeasurable and metaphysical concepts bound up in counterfactual estimates.

So, if measurement does not dispel morality and metaphysics, what does it do? One important body of literature especially examines its economizing role in nineteenth-century England. Scholars working across Actor-Network Theory and the concepts of governmentality scholars have documented how economic authority over other civil claims to expertise brought civil regulation under the purview of economic measurement. Under 'advanced liberal' forms of rule, 'calculative regimes of positive knowledges of human conduct are to be replaced by the calculative regimes of accounting and financial management but also to a more general problematization of the forms of reciprocal social understandings that were embodied in rationalities of trust' (Rose, 1993: 295). This development is reflected in the way contemporary neo-liberal accounts of civil regulation tend to treat its development as a matter of economic

efficiency; that is, a calculation of costs and benefits. For example, Glaeser's (2003) account of the regulatory state suggests its historical formation in the nineteenth century was a rational process of efficient economic development.

In addition to attributing rationality 'behind the back' of actors, neoliberals have also sought to characterize civil regulators as scheming, self-interested calculators. Regulatory agencies can thereby be viewed as vehicles of intrusive and self-interested government whose actions stifle and control. Although markets are imperfect, as recognized by transaction-cost economics, standards-based regulation is *measurably* worse. The Alkali Inspectorate's powers to enforce acid dilution standards are often characterized as 'archetypal command and control regulation' (Pontin, 1998: 663).

However, the term 'command and control' belies the political and historical circumstances in which the Inspectorate's powers were developed; incumbent legal avenues protecting private property shaped the new civil regulatory regime. Insofar as it invokes images of Soviet production quotas, 'command and control' is part of a twentieth-century projection of economic terms onto the nineteenth century – a projection that obscures the historical and cultural contingencies of the relations between expertise, industry and liberal government.

In the nineteenth century the Inspectorate's powers of inspection and enforcement developed in close consultation with industry such that the profitability of the alkali industries was not impinged upon. An 1863 inquiry into damage from industrial pollution was led by Lord Derby, who had a personal stake[4] in its outcome because he held property affected by muriatic acid (MacLeod, 1965). The committee led by Lord Derby initially agreed 'not to prescribe the specific process by which nuisance should be prevented' (MacLeod, 1965: 89). This statement prefigures what environmental economists would formalize a century later as 'flexible' regulation through economic instruments – an historical novelty that further emphasizes the value of situating emissions trading in the lineage of civil regulation rather than beginning in the 1960s with Coase's critique of taxation.

Macleod's (1965) account of the development of the Inspectorate shows that Smith's authority to 'control' pollution outputs did not extend to impinging on the bottom line of the alkali industries. In fact, Smith worked with the industry to develop condensation measurement and abatement techniques. In the years following the passage of the 1863 Act, the liquid form of muriatic acid condensed according to statutory regulation became more valuable than the output of many products of the works.[5]

Furthermore, the relationship between legal recourse to torts protecting private claimants from nuisance on hand, and the development of civil regulations on the other was not simply the subjugation of the former by the latter. Civil regulations did not simply threaten private rights. As Pontin asserts,

> the main debate centred *not* upon whether tort remedies should continue to be available, but whether they should be strengthened in the light of the challenges to their efficacy from the standpoint of the plaintiff arising from the scale of industrialization. (my emphasis Pontin, 1998: 664)

This reinforcement of private law and public law through pollution regulation is significant with regard to how we think and write about the history of emissions trading and 'command and control'. Two further aspects of the inspectorate are also noteworthy. Firstly, Whiggish accounts attributing a causal role to 'responsible public opinion'[6] in developing the civil regulations during this period tend to sharply distinguish civil and private nuisance regimes based upon torts. To counter the widespread belief that industry had effectively bought itself immunity from further tort claims by being subjected to inspections,[7] Smith proposed a 'nuisance liability tribunal', chaired by the Alkali Inspectorate (Pontin, 1998: 671). This proposal was one of many at the time, highlighting both the ongoing commitment of civil actors to preserving legal avenues for the prevention of private nuisance. Industry ultimately frustrated such efforts at tort reform by highlighting the ambiguous causal relationships between sources and receptors of nuisance (MacLeod, 1965).

Secondly, the emergence of the civil scientist is noteworthy because Smith did not simply technically enforce the 'command and control' provisions of the Alkali Acts, but he saw his work as a calling. As Rose (1993: 297) notes, the establishment of liberal forms of rule is not simply a question of the proliferation of new objects of authority – in this case, 'nuisance'. 'It is also a matter of a certain ethos of authority – its distinctive character, spirit, and manner of reflecting upon itself and its practice' (Rose, 1993: 297). Whereas the statutory provisions called simply for the measurement of muriatic emissions, Smith continued to develop his theories of chemical climatology (Gorham, 1998), reporting on sulphuric acid transport as well as muriatic emissions from industry. There was a metaphysical element to Smith's motivation that was anathema to neoliberal accounts of regulation, which treat any metaphysical claims with suspicion. For Smith, muriatic emissions were not reducible to economic

calculation because they were undesirable or inefficient; to him, acidic emissions were an 'evil'. His later reports lament that 'even 1%' escape of muriatic emissions was an evil (MacLeod, 1965). This moral language suggests Smith viewed his role as more than simply performing the job specified in the statutes.

These legal, moral and metaphysical elements of the Alkali Inspectorate are significant because neo-liberal measures of the economic efficiency of pollution regulation, such as the acid rain regulations examined below, treat the moral components of regulation as a separate element from what is measurable. The underlying neo-liberal model of economic rationality performed by the separation of these calculations is that private interest is a more powerful incentive than civic duty. However, the development of the Alkali Inspectorate suggests that civil regulations and private property were mutually reinforcing. Despite the failure of torts claiming nuisance damages to property holders, Smith successfully negotiated with industrialists by presenting regulation of alkali works as both a moral necessity and technical practicality.

For this book, the significance of the Alkali Inspectorate is not that it was 'socially constructed' by Smith in the sense of anti-realist epistemology pursued by many science studies scholars. Rather, it is that the Inspectorate *made* a new society that met the shortcomings of *laissez faire* to adequately grasp and assume responsibility for the problems of acidic emissions. This post–*laissez faire* society required the standardization of measures of pollution output to circulate between authorities and relevant publics to have their significance assessed and interpreted. Macleod (1965) draws particular attention to the role of Smith in mediating these exchanges and providing a moral voice to bolster the concerns of citizens. This mediating role highlights the fact that scientists are not detached experts, but that they pursue moral agendas through their work of measurement and standardization.

Whether Smith's efforts hindered or supported the development of industry by standardizing pollution-abatement technologies remains subject to dispute. Neo-liberal accounts of the development of civil laws such as those enforced by the Alkali Inspectorate, view such regulations as an economic, rather than a moral, matter.[8] Some neo-liberal accounts elevate self-interest to the primary causal factor in regulation (Glaeser and Shleifer, 2003). Other neo-liberal accounts of pollution-technology development have drawn attention to 'win-win' outcomes for industry and the environment whereby profitable self-interest is compatible with lower pollution (Porter and Van der Linde, 1995). The differences between these accounts are important because these differences are also

used in justifications for or against regulation.[9] A crucial point raised when examining the differences in these accounts is the claim that private property regimes based upon torts should replace civil regulations altogether. For example, Desrochers argues that 'the best way to craft "well-designed" environmental regulations is to return to a private property rights approach to mitigating pollution problems whenever possible' (Desrochers, 2008: 538). This assessment of environmental harm expresses a liberal governmentality. Such frameworks of harm assessment are relevant only as private property reflects an ideal view of the liberal state as one which wields power from free and voluntary exchange between individuals (Burchell et al., 1991). This market ideal is also reflected in the term 'command and control' because it implies an undesirable imposition on such free exchange.

However, the Alkali Inspectorate did not represent a threat to this liberal vision of the state, but rather constituted a response to the pollution crisis that strengthened liberal ideas of government. The Inspectorate gained its powers under the proviso that industry was protected and individuals remained free to pursue tort claims against it. Furthermore, the neo-liberal narrative of government dictating technological standards implied by the term 'command and control' occludes the importance of profitable waste-reuse techniques in the passage of the Alkali Acts. Unlike climate-change emissions, whereby large structural changes to the economy are required to meet appropriate mitigation targets, the Alkali Acts – and later acid-rain provisions examined below – saw the progressive development and implementation of a known technique to manage acidic emissions.[10]

Smith's rhetoric of protecting the common good was not necessarily decisive in the passage of legislation. As Jasanoff argues, a 'cost of the British stress on virtuous expert bodies has been to protect the assumption of common vision itself from critical examination' (Jasanoff, 2005: 12). Unsuccessful attempts to legislate a general health board demonstrated the contested nature of this common vision. These attempts failed because local health boards refused to cede the power to dictate local health management to central authorities (MacLeod, 1965). The character of the problem of smoke nuisance is crucial in this regard. For the majority of the population surrounding alkali works, nuisance became a regular and predictable fact of life. In Macleod's analysis, muriatic acid emissions lay just within a 'safety zone' of public ignorance and national apathy; 'distance from the heat of public debate' equates to a greater likelihood of successful state handling of issues (MacDonagh, 1958).

However, the Inspectorate's regulatory powers would ultimately be outflanked by new patterns of industrial production: the Leblanc process was superseded (MacLeod, 1965). The point here is less that this 'outflanking' indicated a failure of government *per se*, but that Smith's work provided the impetus for air-quality monitoring, a much later development, and laid the groundwork for centres of calculation to quantify the health and environmental effects of air pollution (see, e.g., Brimblecombe, 1987). The delineation of voluntary participation from industry prescription and acceptable/unacceptable nuisance for the wider British populace was part of the liberal machinery of government. As Rose notes, government does not 'extend rule from a central site of power across the inhabitants of a national territory. Rather, relations are established between various centres of calculation and diverse projects of rule – more or less "rationalized" as the case may be' (Rose, 1993: 287). The role of civil science in framing the boundaries of industrial pollution through the concept of nuisance exemplifies this extension of power in the sense that diverse projects from the moralizing of nuisance to the measurement of emissions were implicated in government. It was not so much 'the state' that expanded, but rather, certain forms of thinking about pollution as something that could be measured, quantified and controlled.

From clean-air laws to acid rain: governing welfare

Acid deposition emerged as a considerable political and ecological problem during the translation of welfare-state imperatives into industrial growth. The bureaucratization of pollution controls was a necessary condition for the British national economy to become a measurable entity. Some scholars following Foucault have argued that the development of national economies corresponded with a 'socialization' of both individual citizenship and economic life in the name of collective security (Rose, 1993: 293). For example, following Foucault ([1973] 2001), Cooper argues that the form of the relationship between population governance, expertise and economics was markedly different before and after Keynesian welfare-state governmental regimes (Cooper, 2008). The calculability of sickness achieved a new salience with the rise of the Keynesian welfare states, whereby liberal governmental relations between pollutants and health were progressively formalized through economic measures, rather than explicitly moral categories.

Electricity networks are a key apparatus for the government of populations within a given territory; however their role in producing various

liberal subjects has largely been unexamined in the governmentality oeuvre.[11] From the early twentieth century onwards, electricity grids were progressively introduced in liberal democracies such as Britain and the United States.[12] The socio-material connections between private residences and power generation made everyday and seasonal habits visible and governable. The electrification of industry and households corresponded with the emergence of the economy as a singular object of analysis and manipulation (Mitchell, 2008) because it provided a set of diverse measures of economic performance that could be analysed together as a matter of aggregate energy demand and supply.

The distinction that has been drawn in governmentality studies, such as by Rose (1993), between liberalism and 'advanced' liberalism is useful in the context of pollution abatement because it signifies a progressive formalization of decision-making and a corresponding exclusion of 'moral language' from expert rhetoric. This transformation is exemplified in the transformation of the pollution crises from 'evil' into something to be managed by technical experts dependent upon counterfactual calculations of market efficiency over direct standards-based approaches. These counterfactual calculations are presented by proponents as approaches more rational than civil. Air pollution transitioned from being a category of 'nuisance' and a metaphysical 'evil' to become an object of expert analysis through epidemiological and air-quality metrics. Public-health experts and, increasingly, economists sought to justify governmental regulation in secular, technical terms.

New forms of industrial regulation sprang forth as industrial expansion lurched from crisis to crisis. Quick technical fixes transferred the responsibilities of supposedly cheap electricity to future and distant populations of people and ecosystems. Power stations were moved away from cities and smoke stacks built higher – the seeds of national, then international, environmental regulations built into these decisions. Eventually, the decision to continue to burn high-sulphurous coal became viewed as a trade-off between local air quality and casting acidifying emissions into ecosystems downwind. Acid rain was thus an outcome of policies directed towards local health outcomes.

Standardization of emissions outputs according to these new health norms embodied a promise of objectivity and safety in science. Clean-air regulations in the United States and Britain would become the archetypal vehicle for scientific regulation, and the basis by which US emissions-trading proposals would be formulated. In the United States, amendments to the Clean Air Act would become the first national emissions trading scheme. The 'Great Smog of London' in 1952, and subsequent

calls for concerted national action to combat smoke in Britain, resulted in the 1956 Clean Air Act, transferring many powers from local authorities to the (national) Alkali Inspectorate, which oversaw the restriction of smoke, grit and dust until the 1960s (Weale, 1992). Similarly, a fatal low-altitude air inversion in a Pennsylvania town was an important contributor to the original US Clean Air Act of 1970.

Sonya Boehmer-Christiansen (1991) documents the politics of these regulations. She shows how the diffuse and deeply contested causes and effects of these pollution incidents were managed through public inquiries, special pleadings and regulatory exemptions for many UK power stations. Such exclusions suggest that environmental and health concerns were secondary to the provision of electricity services in the planning of the British post-war governmental order, with environmental impacts a distant, lower-order concern.

The 1971, the Royal Commission on Environmental Pollution noted in its first report a 'steady reduction in the emission of smoke and Sulphur Dioxide (SO_2) into the air over Britain' since the passage of the 1956 Clean Air Act (quoted in Auliciems and Burton, 1973: 1064). The report implied that regulations were responsible for 'downward trends in smoke and Sulphur Dioxide pollution [which] will continue only if there is no relaxation in applying the provisions of the Clean Air Acts and the Alkali Etc. Works Regulation Act' (quoted in Auliciems and Burton, 1973: 1064).

However, it is unlikely that the national Clean Air Acts played a significant role in transforming patterns of industrial production. As with the original Alkali Inspectorate's powers being outflanked by industrial expansion, the UK Clean Air Acts only served to reinforce changes to energy use and emissions that were already well underway. The effect of replacing coal burning in open fires with gas and electric central heating largely eclipsed the emissions-reducing provisions of the Act (Auliciems and Burton, 1973). Local planning regulations saw the progressive retirement of power stations in London, itself, as populations dispersed into the suburbs[13] (Laxen and Thompson, 1987). This separation of emissions sources from populations meant that no pollution events like the 1952 smog were repeated, with the result that the quantity of sulphur particulates in the London atmosphere declined (Laxen and Thompson, 1987).

A key role for US and European environmental economists and civil scientific actors was the quantification of acid damage to flora, fauna and urban populations. The effective governing of sulphur emissions depended upon such quantifications being viewed as trustworthy and

technically sound. As with the concerns of the landed gentry, whose political pressure saw the formation of the Alkali Inspectorate, the basis of the European negotiated Long Range Transboundary Air Pollution (LRTAP) treaty lay in both aesthetic and economic concerns about changes to property and natural resources.

The concept of 'Critical Loads' was developed from observations of changes to fishing resources in Sweden and agricultural resources in Norway. Scandinavian researchers[14] hypothesized that the effects of coal-fired industrial emissions far away from their sources were being felt, as isolated freshwater fish populations and forests showed signs of acid-deposition effects. In North America, research by Gorham and others into the effects on lakes of the Sudbury, Ontario, smelting facility (the largest source of sulphur emissions in the world at the time) led to detailed monitoring of the effect of pH changes on a range of aquatic biota (Gorham and Gordon, 1960; 1998: 157). These studies, as well as those of compromised peatlands in Northern England, constituted the foundation of concepts of ecosystem resilience that underpinned environmental regulations.

By the mid-1950s, studies of acidified forests and streams in rural Scandinavia (Barrett and Bordin, 1955), the Lake District in Northern England and northeastern United States suggested that acid deposition was caused by fossil-fuel combustion transported from urban centres of air pollution (Gorham, 1998: 154). These claims led in the 1970s to disputes between Scandinavian officials and the Central Electricity Generating Board of Britain (CEGB), resulting, eventually, in inter-European Negotiations. These negotiations culminated in a push for Britain to join other European countries in committing to reduce its sulphur dioxide emissions to 30 per cent of their late-1970s levels (Sundqvist et al., 2002; Patt, 1999). The agreement that was reached (LRTAP), however, required space to negotiate uncertainties inherent in atmospheric modelling – namely the acid-carrying capacity of local ecosystems and the political contingencies of concern about particular vulnerabilities highlighted by ecological research.

Despite being premised on 'standards' and 'trading' respectively, the Long-Range Transboundary Air Pollution (LRTAP) and the US Clean Air Act are examples of heavily formalized regulatory responses to the issue of acid rain. Both relied upon the authority of economic experts. With LRTAP, these expert economists and civil experts managed the implementation of pollution-reducing technologies. As we shall see, the authoritative guidance of expert economists was also a necessary condition for the acceptance of regulation based on trading.

During the post-war period, concerns about air pollution adversely affecting the health of populations, forests, lakes and streams could be managed by industry in one of two ways[15]: moving the source and recipient of pollutants away from each other; or preventing their interaction in the first instance by changing fuel type or 'scrubbing' emissions at their source by attaching a 'Flue Gas Desulphurization' device. Mixing fuels with different sulphur content was also possible; however, this only changed the quantity of emissions, not the underlying chemistry.

The role played in the British government by the CEGB[16] (as discussed above) meant that options for managing the sulphur emissions from power stations would be given special consideration. The board recommended increasing the minimum height for smokestacks on new facilities and making them higher on older ones. The outcome of this recommendation, once implemented, was improved air quality nearby but emissions were deposited much further afield – as far as Norway and Sweden. The resulting acid deposition was the first trans-boundary air pollution problem (not related to nuclear weapons testing) around which an international convention was signed (Haas, 2004).

As with the concepts of nuisance provisions and air quality, the objects of acid-rain regulation were produced in conjunction with culturally mediated ideas and experiences. Concerns about *which* rivers, *which* streams and *which* forests were being deleteriously affected needed to be translated back into an object that could be subjected to policy. The object, through which acid rain thresholds of tolerability would be apprehended, came to be referred to as 'critical loads'. A vast European techno-scientific project was created to make this new object into a quantifiable, measurable device that could be manipulated by policymakers. This desire for expert control through quantification was also manifest in Smith's complaint that being unable to make 'nuisance' quantitatively tractable was an impediment to his statutory powers. In the twentieth century, the concept of critical loads was developed by ecological scientists to provide a more rational, formal measurement of environmental harm in order to bring about closure to debates between the competing interests of European countries.

The concept of critical loads was developed following observations linking acid rain and the lack of fish in southern Norwegian surface waters (Asdal, 2008: 128). Environmental groups and policymakers accepted that large parts of the country showed significantly depleted fish stocks as a result of acidic deposition. The question arose of how much the deposition of acid compounds should be reduced to restore fish stocks. These critical loads of acidity were defined as 'a quantitative

estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge' (Nilsson and Grennfelt, 1988). Models of the 'Acid Neutralizing Capacity' (ANC) of bodies of fresh water were constructed to provide policymakers with an understanding of the relationships between reduced depositions and recovered fish stocks. As Asdal argued:

> Built-into the model of the ANC limit was the assumption that nature is a flexible entity. The weathering capacity could be reduced, however, only to a certain limit (that is, the ANC limit). Reducing the buffering capacity would, accordingly, reduce nature's ability to 'resist' acids. Thus a calculation of risk was built into this. (Asdal, 2008: 128)

The concept of critical loads thus operated as a boundary-ordering device because it reconciled inherent uncertainties about 'limits' with the authority of civil scientists to influence policymaking. Critical load is an indispensable conceptual mechanism in environmental governance because it provides interpretive flexibility for policy negotiation. Only from such 'boundary objects' could large-scale collective calculation become possible, whether through a market-like approach (as in the United States) or the Integrated Assessment Modelling (IAM) of the LRTAP (Lidskog and Sundqvist, 2002: 93).

Economists attempting to provide a definitive cost–benefit analysis failed to 'cool' the controversy over Scandinavian acid deposition. As Patt (1999) has documented, critical loads were developed as an alternative quantification technique that were viewed as less value-laden and more reliable than cost–benefit analysis. The LRTAP treaty has been celebrated for creating an 'epistemic community' of scientists and policymakers who 'spoke truth to power' (Haas et al., 1993; Haas, 2004) by developing accurate scientific methodologies and applying them to the problem of acid rain. However, other accounts of the role of science reject such apparent separations of politics and science, pointing to a more nuanced performance of quantification in the negotiation of LRTAP (Lidskog and Sundqvist, 2002; Sundqvist, 2003; Sundqvist et al., 2002; Patt, 1999) and a number of other European air-pollution abatement policies.[17] These studies of IAM construction have highlighted the role of ambiguity in civil science/policy brokerage (Sundqvist, 2003). 'The boundary object of Critical Loads could also be viewed as an object which co-produces science and policy, making them more dependent on and close to each

other, and thereby strengthening the regime' (Lidskog and Sundqvist, 2002: 93). The importance of ambiguity in facilitating negotiation is reflected in this statement by Jan Thompson, the chairman of the LRTAP executive committee:

> The secret behind the Convention's achievements lies in its flexible framework for joint initiatives, in the political backing it has enjoyed, but first and foremost, in the close interplay between science and policy. The development of new instruments builds on a serial scientific foundation generated by an international network of experts and on interaction between policy makers and scientists with a shared perception of where to go and how to get there. (Thompson quoted in Lidskog and Sundqvist, 2002: 93)

Despite the executive committee's lack of explicit commitment to pursuing policy in experimental stages (as with the EU ETS), this statement reflects the ideals of humility and shared reflection in Callon's formulation of 'civilizing markets' (Callon, 2009). The emphasis on flexibility also encapsulates the importance of interpretive flexibility inherent in the concept of critical loads that allowed specific national and local concerns to be tied to rationalized, formal policy tools, as constructivist accounts highlight. The statement also highlights the historical continuity with earlier forms of liberal expert government. Just as Smith harnessed the interpretive flexibility of the concept of nuisance to assert his expert authority over emissions regulations, expert economists presented specific outputs from the Integrated Assessment Models (IAMs) that they judged would allow decision-makers to reach an agreement on emission reductions (Patt, 1999). These judgements secured the authority of economic experts. Furthermore, Thompson's statement underscores that the greater precision of measurement afforded by high-technology modelling does not necessarily lead to more harmonious policy outcomes. What is important is the flexibility of concepts such as critical load and their consequent capacity to align the perceptions and goals of unaffiliated (or loosely affiliated) national and local concerns in the policymaking process. IAMs were powerful because they aligned human and nonhuman actors in the pursuit of the goals framed by LRTAP (cf. Rose and Miller, 1992: n27). River- and forest-monitoring devices, civil-society group interests, sulphur-abatement technologies and electricity networks were brought together through the IAMs, which facilitated economic decisions about sulphur-emission-reduction targets, technologies and strategies. Economists were thus powerful political

actors because they promised to provide models to precisely represent a broad terrain between the 'natural' world of rivers and plants on one hand, and the human world of industry and politics on the other.

Governing acid rain in America: neo-liberalism and the rise of emissions trading

Critical loads were also a crucial boundary object in establishing a calculative framework for policymakers in the United States. This calculative framework was built upon a market-based approach, rather than on the Integrated Assessment Model used in Europe. The market in tradable sulphur-emissions permits brought closure to a dispute that had developed since the 1970s between Eastern high-sulphur and Western low-sulphur coal producers (and the power stations they supplied). Therefore, the market-based approach of the 1990 amendments represented the culmination of some two decades of economists criticizing standards-based regulation on the grounds of economic inefficiency.

Primary health standards-based regulatory approaches in the United States were implemented to prevent atmospheric events in which industrial emissions would gather into a lethal form.[18] The Environmental Protection Agency (EPA) sought to protect public health through a set of 'primary standards' applying to a basket of six[19] 'criteria pollutants', including sulphur oxides. As with the 1956 British Clean Air Act, the motivation for controlling sulphur dioxide at this time still rested on concerns about human health and aesthetic considerations of visibility,[20] rather than ecosystem effects (Hays, 1998).

Standard-setting powers involved an implicit model of innovation disputed by environmental economists. Sulphur emissions were managed under the original 1970 Clean Air Act, which provided the agency with the power to set and enforce pollution-control standards by monitoring 'adverse effects' and prescribing methods and equipment for controlling them (Jasanoff, 1990). Despite this power, the agency set standards[21] for sulphur dioxide emissions that could be met in a number of ways. including scrubbing or low-sulphur coal substitution. The hope was that the old plants would gradually be phased out, leaving only a stock of plants compliant with 'New Source Performance Standards' (Carlson et al., 2000).

However, power plant operators failed to follow the innovation path assumed by the standards approach. The standards frame overflowed, as economists would go on to note, because of incentives to extend the lives of existing dirty plants by replacing worn equipment rather than

by retiring the entire plant (Ellerman, 2000: 14). As a result, throughout the 1970s utility companies across the United States constructed 429 stacks up to 500 feet tall on coal-fired boilers in order to satisfy local air standards, a strategy that simply ensured the transport of emissions to jurisdictions downwind. Despite this feverish rate of chimney construction, many states failed to meet ambient air quality standards. The 1977 amendments[22] to the Clean Air Act were tweaked in subsequent years as this failure became apparent. The amendments also required plants built after 1978 to have scrubbers, an attempt to protect the jobs of coal miners in states with high-sulphur coal. The relative economic disadvantage of burning high-sulphur coal was thus reduced, effectively raising the costs of sulphur dioxide abatement at new plants across the country and serving to give the power plants that existed before 1978 a 'seemingly indefinite life'(Ellerman, 2000).[23]

These new standards were critically scrutinized by the burgeoning field of public-choice economics, which saw regulation as a distortion of efficient 'competitive markets'. These economists held that the rents transferred through the 1977 standards were exemplary of 'special interest' capture of environmental policy because old plants captured subsidies through the favourable emissions baselines they were granted. Ackerman and Hassler's (1981) account of the 1977 Clean Air regulations bears the rousing subtitle, '[H]ow the clean air act became a multibillion-dollar bail-out for high-sulphur coal producers and what should be done about it'. The authors argued that the amendments were the result of a concerted campaign by dirty Eastern coal generators to ensure they would not be disadvantaged relative to Western generators with access to less-sulphurous coal. Eastern coal producers had given up their campaign to weaken pollution standards and instead allied themselves with environmentalists to impose a uniform standard that would require scrubbers on both new and existing plants – the most costly solution. The resultant redistribution between high-sulphur and low-sulphur states saw one commentator observe that the political calculation of the Environmental Protection Agency appeared to be that 'large costs could be passed on to a diffuse consuming public with few political repercussions whereas even moderate costs concentrated on the high sulphur coal producers would prove politically sensitive' (Daly and Mayor, 1986: 157).

The displacement of sulphur emissions further afield in response to the 1977 amendments had the additional effect of bringing 'acid rain' into the American public consciousness as the environmental problem *de jour*. Claims that changes to pH levels in forestry ecosystems were damaging

foliage, forests, lakes ecosystems and infrastructure were apprehended by both the mass media[24] and nation-wide scientific research in the form of the National Acid Precipitation Assessment Program (NAPAP). The program followed the ill-fated, reductionist Cost-Benefit Analysis in Europe. Its official role was to perform complex calculations, integrating economic and ecosystem monitoring information to provide 'scientific information and analysis concerning the costs, benefits, and environmental effectiveness of [acid rain regulation]' (NAPAP, 1991: 3).

The American culture of public science from which NAPAP arose was caught between two conflicting developments that provided the political foundations for emissions trading. On the one hand, the relatively sudden rise of highly specialized public-interest environmental advocacy groups[25] placed pressure on the EPA to translate into regulation the monitoring of hundreds of widespread pollutants. However, unlike the nineteenth-century situation discussed above, these pollutants were only detectable at minute concentrations. To legitimate socially, politically and economically costly decisions, US policymakers sought the mantle of 'good science' through claims to safety, rather than 'tolerance', (Jasanoff, 1992). Civil science seemingly offered the means to avoid claims of bias by anchoring their authority in complex, technically sophisticated precautionary risk-assessment techniques.

On the other hand, new demands of accountability placed pressure on the government. The public-choice economics of Daly, Ackerman and others was reflected in a new federalism that brought the regulatory state under scrutiny for its distributional effects. The election of Ronald Reagan brought with it a theatre of congressional inquiries into 'wasteful spending'[26] and newly appointed iconoclastic regulatory agency staff gave expression to public disquiet at the amount of resources, time and expertise required to tame newly articulated environmental risks. The responsibility of monitoring hundreds of complex trace industrial chemicals was met with increasingly abstract and hypothetical harm-prevention scenarios,[27] leading one EPA administrator to suggest that he could no longer reassure the public '[Y]ou are home free with an adequate margin of safety' (Jasanoff, 1992: 199). The competing demands of scientific objectivity and economic efficiency led to direct conflicts between ecological and economic expertise. Environmental economics capitalized on these conflicts.

Environmental economists were instrumental in constructing a crisis of authority that they used for their own ends. For example, Crocker's (1968) impetus for the reform of air pollution arose from 'legitimatized control authorities [who] do not have and perhaps do not care

much about unbiased and precise information on emitter cost-savings and receptor damages'. Instead, he argued the 'information the market generates about decision consequences is unbiased and precise' because 'secure property rights girdle a market' (Crocker, 2008: 5). This diminution of 'central authority' in favour of the market reflects the Coase Theorem, namely that private actors are superior processors of information to any external authority, regardless of the initial assignment of property rights. Therefore, the role of government is to clarify these rights.

However, neo-liberalism did not represent the clarification of rights and minimal government, but rather the further centralization and extension of government using the apparatus of the 'market' as a means to determine its boundaries (Rose and Miller, 1992; Mitchell, 2011). New forms of accountability were enforced by bureaucrats to implement regulatory standards that could be seen to impinge on industrial productivity. As Will Davies (2008; 2009b) has argued, the dynamic of 'self-loathing bureaucrats' enforcing new measures designed to displace 'inefficient' ones is a central contradiction of the neo-liberal state. Developments under the Reagan administration are notable in this regard: an extension to the mandate of the Office of Management and Budget, which was given oversight of risk-management technologies; and the appointment of partisan Republican Anne Gorsuch[28] to head the EPA as part of a 'New Federalism' designed to disentangle state and federal powers to regulate industry (Jasanoff, 1990). Gorsuch implemented reforms aimed at restraining civil expert judgements about pollution standards in favour of minimal and simplified regulation. These proved unpopular with both Democrats and moderate Republicans, and Gorsuch's tenure lasted just 22 months. However, more partisan appointments during Reagan's term further challenged the authority of civil and bureaucratic expertise seeking to develop and refine pollution-control standards.

By the late 1980s it was clear that scientific research was not 'cooling' the controversy but simply 'kept the issue boiling' (Hays, 1998: 259). Divergent expert ecological and economic values were publicly articulated with the 1987 release of the interim NAPAP report under the Reagan administration. The report's authors resisted making specific policy recommendations and so Eville Gorham and other advocates resorted to the public arena. Gorham, a pioneer of 'critical loads' complained that the report 'conveys no sense of urgency but instead provides a rationale for going on researching without any sense that controls may be needed' (quoted in Shabecoff, 1987).

The jostling about an accepted definition for what constituted an acidified lake showed underlying differences in values and motives between Gorham and the NAPAP interim report's lead author Laurence Kulp. The report counted as acidified those lakes that had a pH of 5 or below. At a pH of 5, only about 10 per cent of lakes in a few scattered areas, notably New York's Adirondack Mountains, were found to be acidified. Moreover, the report stated that the acid content of the lakes appeared to be at a steady state; that is, they were not becoming more acidic (Shabecoff, 1988). Gorham claimed that a pH of 5.5 was a better definition of acidification, because at that level many aquatic organisms were being affected. At that level 20 per cent of lakes in sensitive areas would be classified as acidified (Shabecoff, 1988). Kulp chose a pH of 5 because below that level sport fish start to show dramatic effects. While other organisms might be affected at lower levels of acidification such damage did not lower the economic value of a body of fresh water. The final NAPAP report valued damages at 1990 levels of sulphur emissions at $5.3 million to $27.5 million annually. It was estimated that reducing deposition by 50 per cent would create economic benefits to recreational anglers ranging from $20 million to $31.7 million annually (NAPAP, 1991).[29] The NAPAP report was inconclusive about the potential effect of reduced acidic deposition on agricultural crops, noting that sulphur and nitrogen were also plant nutrients (NAPAP, 1991: 380).

European experts developed the concept of critical loads with reference to their own interpretations of uncertainties in atmospheric transport models and deposition data. In North America, however, such boundary objects were negotiated with a greater emphasis on economic efficiency. An annual conference was organized 'with the recognition that, if we are to have an environmentally sound and cost-effective control program, it is important to understand the relationship between sources and receptors of acid deposition' (White, 1988: xi). However, by the time of the third conference in 1986, some participants had given up on the possibility of a regulatory regime derived from atmospheric transport models. One atmospheric modeller highlighted the complexities in establishing definitive source–receptor relations because, he pointed out, many atmospheric factors simply defied disentanglement (Hales, 1988). The Environmental Defense Fund's Michael Oppenheimer concluded the conference with a call to action: 'Look, forget the complexities; we're going to go ahead and take the attitude that we have to be pragmatic and we're going to do something' (Oppenheimer, 1988).

Kulp resigned after the release of the interim NAPAP report. He published a lengthy article (Kulp, 1990) in *Regulation*, the magazine of

the Cato Institute think tank, claiming that acid rain would 'not retard the growth of crops', and that it has had 'little or no negative effects up to the present on forests in the United States'. He also claimed that researchers 'have not demonstrated indirect health effects from acid rain in drinking water'. Kulp later claimed to one scientist (Olson, 1995) that 'the cost to society of the acid rain portion of the Clean-Air Act of 1990 would total at least forty billion dollars, but that the benefits will be hardly perceptible. Furthermore, Kulp also suggested that the cause of acid rain lay with ozone and weather interactions, rather than with sulphur emissions. Therefore, he warned that 'we wouldn't want to spend a lot of dollars on things that aren't important' (quoted in Oppenheimer, 1988).

These remarks underscore the governmentality insight that liberal rule does not simply develop by inventing new objects of government (such as 'the market' or 'economic efficiency'); rather, it is also a matter of an 'ethos of authority' that can be reflected upon by its proponents. Economists' rhetoric of wastefulness signified an eclipse of the disciplinary, institutional, ethical and discursive model of 'civil science' documented in the Alkali Acts by pragmatic environmental economic experts. These experts assuaged public concerns over both accountability and safety. This new class of civil expert saw the opportunity to mediate regulatory disputes by providing the flexibility of a market-like mechanism for Republicans, whilst delivering a significant environmental outcome.

Framing economic actors: the target and the ratchet

A key difference between the LRTAP, in which targets were translated into standards by national and regional regulatory authorities, and the US experience, was the heated character of public debates about what was worth protecting. The European negotiations regarding LRTAP saw international stoushes reinforce national 'Natures', as regulatory actors rallied around 'Norwegian Rivers' and 'Swedish Forests' for example.[30] These constructions were informed by centres of calculation designed to manage and disclose data regarding these culturally valorized sites of concern. Hordijk and his colleagues created space to negotiate different ways of telling the truth about pollution. Whereas European scientists operating as representatives of various 'Natures' held their position of authority by also negotiating environmentally salient risks, judgements about how to bring American 'Nature' into its economy were marked by expert disagreements about what should be accounted for, as well as what was at risk.

Concerned American regulatory scientists sought a compromise between conflicting values, and they attempted to redress the failed attempts to agree on the parameters of cost–benefit analysis. Over 40 unsuccessful attempts to pass bills imposing standards for sulphur emissions were made during the 1980s (Ellerman, 2000). As it became clear that the EPA would be unable to regulate sulphur dioxide, the most promising avenue for environmental advocates was to seek a higher level of legitimacy. NGOs such as the Environmental Defense Fund effectively tied acid-rain regulation to the mantle of an 'Environmental President' during the lead-up to the 1990 election campaign. One of incoming president George H.W. Bush's first acts was the 1990 Clean Air Act Amendment. After intense jostling over baselines and allocations,[31] the first-ever national cap-and-trade scheme was born.

A variety of 'economists in the wild' were required to negotiate the key characteristics of the sulphur trading scheme, two of which are relevant to this chapter: The first involved the negotiation of a gross target for sulphur-emissions reductions. The reduction target was arrived at through a negotiated compromise between environmentalists' demands for 12 million ton reduction of industry allowances and industry pleas for 8 million ton (MacKenzie, 2009b). All major accounts of the episode agree that the 10 million ton target was a compromise, rather than being demonstrably optimal (Ellerman, 2000; MacKenzie, 2009b).Civil experts, such as Hays (1998 [1995]) have argued that the industry figure was an ambit claim designed to extract the most cost-effective agreement, rather than being arrived at with the methodological rigour of the critical-load–based 12 million ton figure. The importance of critical loads to this negotiation highlights the ongoing role for civil expertise, rather than its eclipse by market forces. The negotiated character of the reduction highlights the accountability of civil science to industry since the mid-nineteenth century.

The second framing aspect of the emissions trading scheme involved the construction of a 'ratchet' device to protect the cap from lobbying by high sulphur-emitting states. As MacKenzie (2009b) argues, surviving pleas for special assistance hinged not only on the credibility of the credits to be traded, but on the ability of those negotiating the legislation to frame the 'game' of allocation as 'zero sum'. To this end, the introduction of a 'ratchet' mechanism was added to the CAAA early in the political in-fighting. It set a maximum of 8.9 million tons on the total annual allowances that could be issued from 2000 onward. If the consequence of detailed rule-making was a total entitlement in excess of that, the allocations of each unit would be reduced pro rata to bring the total down to the requisite level.

As MacKenzie (2009b) suggests, any benefit from attacking the ratchet would have been shared by all the utilities involved, making the balance of cost and benefit of fighting against the ratchet quite different from fighting for a rule that would have specific advantages for one's own state or company. The ratchet mechanism managed to quarantine the problem of allocation from the intended effects of the market.[32] The ratchet ended up clawing back some 10 per cent of allocations, twice the level anticipated by those involved. The ratchet also brought closure to the adversarial relations between source and receptor states as they developed throughout the 1970s and 1980s.

Earlier critiques of emissions trading focused on interest groups in regulatory organizations or provided cultural theories of the market epistemology of regulation. These critics lamented market-mechanisms 'depriving [policymakers] of the very language needed to think about public purposes.... Market imagery transforms the public's view of itself from one of an active, deliberate citizenry to one of a gaggle of consumers shopping for policies from shelves stocked by governmental experts' (Landy and Plotkin, 1982: 32). Therefore, critics feared that the rise of emissions trading had 'a built-in tendency' against redistributive policymaking because economic discourse robbed the public of the appropriate language to articulate the collective good (Meidinger, 1985). However, thanks mainly to the ratchet, the success of the Title IV Amendment in largely reducing (and to some extent coinciding with) overall reductions of emissions of sulphur has been accepted by many later assessments. As one interviewee put it, the promotion of 'hysterical projections'[33] of increased costs due to new regulation are an integral part of the public-relations repertoire of industry. A key effect of such projections was to increase the initial allocation of permits; however, thanks to the ratchet, the over-allocation did not diminish the effect of the 'cap'. In this way, the ratchet was a necessary condition for successfully framing permit trading.

Banking and fuel switching: the keys to US sulphur permit trading scheme success

The 'ratchet' is an important detail of the history of emissions trading that is often omitted from mainstream accounts, which instead highlight the cost savings that permit trading stimulated. For example, Zwaniecki (2009), writing for the US State Department, cites 'productivity improvements in coal mining' and freight rail deregulation as the reason for the scheme's success but does not mention the ratchet. Such omissions are

consequential for the applicability of sulphur permit trading to carbon emissions trading because they run counter to the ideals of humility and shared reflection proposed by Callon. Where the LRTAP was brokered by civil experts directed towards politically acceptable outcomes, the neoliberal attacks on environmental expertise obscured the original goal of protecting forests and rivers. Rather, the economic efficiency of the regulation has often been presented as an end in itself.

This distinction between European and American approaches is not simply an ideological or rhetorical one, but reflects decades of economists intervening in regulatory policy. Environmental economists 'in the wild' did not simply take the Coase Theorem as a scientific proposition to be tested in a disinterested manner, but shaped *agencements* around its central tenets. For these economists, the 'textbook' appeal of emissions trading hinges on the 'dynamic efficiency' hypothesis.[34] This hypothesis states that flexible regulations provide the economic incentive to innovate that is 'typically weak or absent with conventional regulatory approaches, especially those that use technology standards' (Burtraw, 2000: 1–2). However, just as Robert Angus Smith's main contribution to policy was the measurement and quantification of existing industrial-emission processes, the US Acid Rain Program – which pioneered pollution allowance permit trading – devised by environmental economists and their allies made no discernible contribution to the development of *new* abatement technologies.

Rather, the power of both the LRTAP and the US Acid Rain Program was their respective alignment of competing political forces with the goal of reducing emissions through trading and integrated modelling. Both policy platforms served to create centralized calculative systems with considerable inertia. For such systems to provide credible regulatory information, enormous costs and investments are required over many years to work out what to calculate and how to calculate it. Standards take time to develop because the local contingencies of technical processes and practices must be accounted for; monitoring systems must be calibrated, tested and experimented with. These investments in the material devices to allow regulation to bring with them what economists call 'opportunity costs', which preclude the investigation of other issues and other formulations of the problem. The very power of environmental economic theories was not only their articulation of dissatisfaction with 'command and control' proposals, but the governmentalization of permit-trading calculations, which implicated calculations of power plants, coal mining, and rail transport innovation. The point here is that any analytical separation between politics, technology

and economics is impossible. Calculations were anti-inventive in the sense that cost estimates of the implementation of known technologies were necessary for the political acceptability of the proposal to create a cap-and-trade scheme.

The fact that all cost savings came from improvements to existing technologies and some efficiency improvements to rail (in the form of substitution of labour for capital) undermines the political salience of environmental economists' distinction between 'flexible' and 'conventional' regulations. This distinction is performative in the sense that it has been used to justify flexible regulatory regimes as well as being used to estimate the counterfactual cost savings produced by the emissions trading provisions in the Clean Air Act Amendments. For example, the Carlson et al. (2000) study of long-run cost savings suggests $700–$800 million per year compared with regulatory programs considered by Congress and characterized by a uniform emission rate standard (Ellerman, 2000; Burtraw and Palmer, 2003). The other main studies (Burtraw and Palmer, 2003; Ellerman, 2000) have estimated savings of around $1 billion annually against these schemes, representing on average 50 per cent in cost savings (Stavins, 2005: 53; Burtraw et al., 2005; Ellerman, 2000; Burtraw and Palmer, 2003).

These economists accept that the scheme did not produce new technologies to abate emissions, which implies that the counterfactual cost savings are essentially speculative about the speed of innovation. The speculative nature of these figures is noted in disclaimers by the economists themselves. Ellerman et al (2000: 295) notes that one 'can't claim *a priori* that Title IV has induced faster innovation [than the standards-based alternatives on the table at the time]'. Furthermore, the authors acknowledge that there is no evidence that incentives to innovate are stronger or weaker under 'command and control'. Rather, the concept of 'command and control' used by environmental economists assumes a static economy in which the price of the technology is a real price or is derived bottom-up from engineering data (Burtraw and Palmer, 2003). Whether scrubber costs actually came in lower than the estimates derived from these calculations due to 'emissions trading or exogenous advances in information processing and control technology' (Ellerman, 2000: 295) is a crucial question the analysts avoid. Rather, market explanations implicitly fill the void between ex-ante projections and observed costs. These disclaimers and ambiguities highlight the performative nature of the distinction between 'flexible' and 'command and control' regulations. Three areas in which environmental economic theories performed the sulphur trading scheme are notable in this regard: the

role of economists in firms' calculations of fuel choice, freight rail deregulation and the establishment of banking provisions.

Many firms economized their coal choice based on a set of uniform calculations of mine-mouth and transportation costs[35] to which the price of allowances was added (Ellerman, 2000: 80–84). Much of the observed 'innovation' produced by the scheme was not 'dynamic' in the economic sense highlighted above. Instead, economists' calculations of a range of possible compliance avenues were a necessary condition for the passage of the Clean Air Act Amendments. 'Trading' was shorthand for allowing compliance choice, rather than submitting to technological standards. This flexibility meant that plant operators:

(1) Bought permits when scrubbers required fixing, which was often a time-consuming and costly process;
(2) Switched to lower-sulphur fuel and began mixing fuels with different sulphur concentrations.

Furthermore, many of the costs associated with specific rules of the scheme fell outside the cost estimates given by proponents. For example, a 'substitution' provision built into the Clean Air Act, allowed companies to switch the factory specified in the legislation for another of their choice and receive allocations of allowances based on the historic emissions of those units instead. In this sense, the hopes for dynamic innovation – for the interaction of firms with technologies of power generation and pollution – were thwarted. The 'seemingly indefinite life' enjoyed by coal-fired power during the 1970s and 1980s was not threatened by the trading scheme.

The prominence analysts give to the role of freight rail costs in their accounts of the successes of Title IV – whether it is included in their 'framing' of the scheme – is instructive. The emissions trading provisions fit neatly with neo-liberal industrial relations policies, which saw the number of (mostly unionized) coal miners in the East cut dramatically as fuel sulphur content was accounted for by station operators. Stavins (2005) and Ellerman (2000:83) both state that the cost of extraction and transport of low-sulphur coal was halved during the 1980s and 1990s across the East and Midwest thanks to deregulation.

Title IV was originally divided into western (Rockies) and eastern (Midwest and Appalachian) pollution allowance markets; however, these were amalgamated early on to encourage the flow of low-sulphur coal to the high-sulphur coal-mining states in the East. This amalgamation allowed Midwestern utilities to take advantage of lower freight

charges by increasing their use of low-sulphur coal from Wyoming and Montana, an approach that would not have been possible if scrubber requirements had been in place (Stavins, 1998). As with the UK Clean Air Act of 1956, other changes in fuel markets, including fluctuations in the price of natural gas and oil, saw shifts in the electricity market favourable to coal (Lohmann, 2006). Since this price fluctuation reduced sulphur emissions in their own right, the result was an oversupply of permits and a drop in price. Ellerman's econometric analysis of the role of freight rail deregulation in cost gains concludes that 'it would not be correct to attribute much if any of the pre-1994 emission reductions to early compliance with the provisions of the Title IV, since these reductions are largely explained by economic factors independent of Title IV ... in economic terms rail deregulation moved the Powder River Basin closer to the Midwest'. (Ellerman, 2000: 104).

The ratchet was crucial in disentangling the program cap from the allocation process, performing the overall efficacy of the first phase. However, the role of freight rail in reducing compliance costs associated with the scheme and the free allocation of permits to most facilities meant that many were 'over-compliant' – holding more permits than necessary for achieving abatement specified in the legislation. Stavins, a key proponent of emissions trading, argues that, 'In regard to flexibility, tradeable permit systems should be designed to allow for a broad set of compliance alternatives, in terms of both timing and technological options' (Stavins, 1998: 79). Power generators exploited this flexibility by banking their free permits into the second phase which effectively hamstrung the incentive to make changes invest in different generating technologies. It is widely agreed that sulphur emissions fell across the two phases of the scheme. A further outcome of the emphasis on 'flexibility' has been to curtail regulatory powers over the scope of the EPA to exercise regulatory power over generators over and above the CAAA. Uncertainty regarding this legal action has further depressed permit prices, which have fallen to insignificant levels since 2008 (Peters, 2010). Because permit price was viewed as the primary mechanism for action to address acid rain, any further extension of EPA powers has been strongly resisted on the grounds that it would be 'inefficient' for the permit market (Peters, 2010).

As Callon argues, the framing process can never be complete and always produces 'overflows' that spark new causes for concern. If this dynamic of framing and overflowing was true of critical loads upon which the LRTAP was based, it is doubly true of the negotiated emissions cap. Critics have raised a number of concerns about the efficacy of

the Title IV provision. Like the Regional Air *Pollution* Information and Simulation (RAINS) model, Title IV was a technocratic project. Under Title IV, however, decisions were made by plant administrators rather than the policymakers of the national government. NAPAP and the EPA have documented that both wet and dry sulphur deposition (and the acidity associated with sulphur deposition) have declined with reductions of sulphur dioxide emissions over a large portion of the Eastern United States following implementation of Title IV. Ellerman (2000) argues that this demonstrated 'proportionality' (cf. Boehmer-Christiansen and Skea, 1991), indicating strong, near-linear, correlations between large-scale sulphur dioxide emission reductions and large reductions in sulphate concentrations in precipitation. As the northeastern states downwind of high-sulphur burning facilities further west were most affected by acid deposition (Butler et al., 2001).

Two areas of concern remain, despite the significance of these reductions. One scientist involved with the NAPAP has argued that damage to some ecosystems has been more prolonged than expected,[36] raising questions about the responsiveness of the regime to emerging data that echo Landy and Meidenger's concerns about scientific authority and public interest (Janetos, 2007). Similarly, Samuel P. Hays (Hays, 1998 [1995]) expressed concern that the celebration of the pragmatic settlement on the national cap of 10 million tons below 1980 levels by environmental economists obscures the critical load calculations that justified a 50 per cent reduction strategy in the first instance. Hays points out that this figure was established in a joint Canada–US scientific commission that President Carter established to provide emission-reduction targets that the Reagan administration abolished when it transferred its functions to the office of the president (Hays, 1998 [1995]: 281).

Constructing and maintaining a market directed towards an aggregate target centralized the regulation of emission sources, closing off any local attempts to regulate acid depositions. If a scrubber broke down, utilities could delay its repair through trading permits, consequently burdening certain communities with the effects of pollution. Although these 'hotspots' were endemic in smaller schemes such as the California Basin 'Clean Air Incentives Market' (Drury et al., 1998), Ellerman (2000) claims that the volume of reductions in the Title IV market overshadowed the problem. Total increases in emissions (1.2 million tons) were much less than the total reductions (6.3 million tons) by the remainder (Kinner and Birnbaum, 2004). Changes to some iconic ecosystems that sparked concerns in the 1980s, such as the many lakes in the Adirondack Mountains, have seen aquatic life forms return (Momen et al., 2006;

GAO, 2002). However, the crude settlement of a 10 million-ton reduction target will arguably preclude the renegotiation seen in the LRTAP. Furthermore, the unevenness of reductions across states[37] has meant that the prospect of 'hotspots' emerging under future trading scenarios (GAO, 2002) continues to haunt the scheme's defenders.

Conclusion: resituating the history of emissions trading

This chapter has examined the rise of civil scientific expertise and its eclipse by environmental economic expertise as the pre-eminent source of pollution expertise for government. Sulphur emissions trading is part of the history of governing populations through regulation. Environmental assessments were not simply a matter of classifying, ordering and quantifying damage to some external 'nature' but were a reaction to planning decisions made at multiple levels of government and civil science. The civilizing processes emphasized by Callon are much more clearly evident in the European approach, which did not draw on markets but agreed commitments negotiated through interdisciplinary perspectives, including those of economists.

Several issues with existing accounts of the US acid rain scheme emerge from this analysis. Lohmann has argued that emissions trading was 'born in the USA' of Coase's neo-liberal attack on pollution taxation in 1960 (Lohmann, 2006). Similarly, Voss (2014) and MacKenzie (2009b) began their accounts of emissions trading with Coase. However, this chapter has examined the continuities between environmental 'economists in the wild' like Denny Ellerman and the nineteenth century liberal civil expertise of the alkali inspector, Robert Angus Smith. This chapter has highlighted these continuities and discontinuities in three ways:

Firstly, markets in sulphur permits did not replace civil expertise, nor did civil regulation threaten markets in soap, textiles or electricity. Rather, liberal markets have continuously relied upon different forms of regulation to ensure soap and electricity can be produced within the bounds of public acceptability. The US sulphur-emissions trading scheme represents a new expert regime of monitoring in the tradition of civil expertise – one that is not just dependent on economists, but also on lawyers, accountants, ecologists and other 'economists in the wild' who brought their expertise and concerns to bear on sulphur emissions.

Situating emissions trading in the history of civil expertise highlights the multiple participants in regulation, and the audiences to which experts are accountable. The interpretive flexibility of 'nuisance' and 'critical loads' were crucial to the negotiation and management of the

different expectations of these groups. Environmental economists' assertions that trading was economically efficient were parasitically dependent upon civil experts who framed acid-rain issues through critical loads. These civil experts not only required an *ethos,* as sociological accounts of bureaucracy have noted (Du Gay, 2000), but required ways of translating new objects such as 'nuisance' or 'critical loads' into governable arrangements. Supported by an ethos of independence, civil experts like Smith made economically calculable what *laissez faire* institutions and processes could not.

A crucial development from nineteenth-century to twentieth-century regimes of acid regulation was the split in civil society (particularly in environmental movements) between experts using moral language on the one hand and claims to economic objectivity on the other. The split is exemplified by Robert Smith employing the secular rhetoric of science to establish his economic authority to restrict pollution and openly voicing his moral concern for nuisance. In opposition to this were environmental economists presenting themselves as disinterested experts, despite their basis of authority being tied directly to matters of political expediency and economic efficiency.

Secondly, examining the nineteenth-century beginnings of civil regulation in this way is important for this book because civil scientific expertise predates the emergence of national economies by over half a century. This further supports the idea that the economy is best thought of as an effect of practices of calculation designed to occupy the future on behalf of a population (Mitchell, 2014). Civil scientific expertise has played a crucial role in creating the calculative infrastructure to monitor economic activity within national territories. Whilst transaction-cost economics presumes that markets are imperfect, the counterfactual *models* – that economists have used to justify emissions trading over 'command and control' approaches – presume a perfectly calculable world.

The third set of arguments concerns the materiality of sulphur regulation. International negotiations of the LRTAP and US Acid Rain Program did not undermine nations' territorial sovereignty, but created new socio-technical *agencements* to convey the concerns of receptor countries to their source. This linking of environmental damage to technical fixes was not only a matter of expert authority as sociological accounts emphasize. Both nineteenth-century and twentieth-century regimes of pollution control required the enrolment of a variety of human and nonhuman actors with the goal of measuring, quantifying and reducing emissions through standards or permit trading. Just as the Victorian era

alkali works owners had decided to pursue condensation before Smith assumed his role, the most notable role played by the environmental economists has been in the area of measurement. These include brokering the development of measurement devices such as continuous emissions monitoring systems, calculating freight rail costs, and devising banking permits to ensure the continuity of operations in power plants. These framed the interactions of market participants by establishing a boundary within which regulated firms could trade permits.

In summary, the regulation of acidic emissions did not progress linearly because of the rationality of science and economics, as liberal accounts of both emissions trading and acid rain regulation suggest. Rather, environmental regulations were part of a cascading series of contingent events and crises resulting from attempts to govern industrial economies through the seeming impartiality of numbers. The shift from welfare to environmental regulation brought with it increasingly complex, labyrinthine monitoring programmes to govern industries and coordinate civil concerns. Neo-liberal environmental economic theories are thus a small, though powerful motor, in the diverse, discombobulating machinery of liberal government that polices the boundary between the economically calculated and its exterior. The next chapter turns to the world's first carbon emissions trading scheme – the NSW Greenhouse Gas Abatement Scheme – to examine how the 'evidence' of success of emissions trading was transferred to the problem of climate change.

3
Governing Carbon Emissions: NSW GGAS

Electricity production in Australia was progressively reformatted according to neo-liberal theories of self-correcting market efficiency throughout the 1990s. The resulting National Electricity Market (NEM) promised to eliminate the wastefulness and bureaucratic excesses of state bureaucratic regimes that were thought to be pandering to a narrow set of industrial concerns, and at great fiscal risk to state treasuries. The creation of a market around the kilowatt hour price of electricity was designed to replace expert bureaucratic judgements about electricity investment with the transparency of a price.

However, the work of drawing boundaries around the market excluded and rejected scientific assessments of the cost of the impacts of greenhouse gases on the environment and future generations. This exclusion was a source of politics in the sense understood by Callon. Against neo-liberal discourse with its kilowatt-hour price *agencement,* a 'sustainability' discourse proposed mechanisms to incorporate the overflows of the national electricity market by pricing pollution and subsidizing renewable energies.

The New South Wales Greenhouse Gas Abatement Scheme (NSW GGAS) of 2003 was developed between these competing discourses of neo-liberalism and sustainability. NSW GGAS preceded the EU Emissions Trading Scheme, often cited as the successor of the US sulphur allowance trading scheme. The legislated policy ambition of the NSW GGAS was to 'reduce greenhouse-gas emissions associated with the production and use of electricity' (anon, 2002). However, the policy used in NSW differed from 'cap and trade' schemes where the epistemic basis for action had been stabilized through the agreed 'cap' (as with the compromise of a 10 million ton figure used in the US sulphur allowance trading scheme). Rather, a baseline-and-credit approach was used that relied

upon expert judgements about counterfactual economic and environmental scenarios to credit emissions reductions. The chapter explores the historical and institutional contingencies that gave rise to expert claims of calculability and objectivity.

This chapter is structured in three sections. Firstly, it outlines the development of the National Electricity Market during the 1990s by critically assessing the role of neo-liberal discourses of privatization and marketization in the production of the electricity market. Regulationist accounts of electricity corporatization have used comparative analysis to show that nation's cultural and technological differences exhibit variety within the neo-liberal regulatory regime (e.g., Levi-Faur, 2006). My account of the electricity market, however, takes its point of departure in the local contingencies of the neo-liberal critiques of expert judgements. Local planning failures were capitalized upon, with promises to replace the inefficiency of bureaucratic judgement with the supposed objectivity, transparency and efficiency of prices. Whereas other jurisdictions incorporated some sustainability dimensions into the calculation of electricity prices, the Australian market was based only on the immediate cost of dispatch. This rejection of sustainability contributed to the creation of the NSW GGAS, fuelling the political appetite for action to curb burgeoning greenhouse-gas emissions from the stationary power sector.

Secondly, my account details the policy context, operation, validation and contestation of key components of the NSW Greenhouse Gas Abatement Scheme: the 'pool' of electricity generators whose emissions formed a baseline against which reductions could be measured; and the two main carbon offsets. The context of the scheme revealed the ways in which supposedly 'voluntary' regulations had failed to stimulate electricity retailers to implement greenhouse-gas–reducing measures during the late 1990s, and therefore the mandatory emissions trading scheme commenced in 2003.

In the final section, I investigate in detail the legislative scheme that led to the creation of carbon offsets. Two of these offsets are examined at some length: the socio-material production of demand-side credits involving, firstly, the replacement of incandescent light bulbs with energy-efficient compact fluorescent bulbs; and, secondly, sequestering carbon in timber plantations. The chapter concludes with a brief consideration of how a governmentality perspective illuminates the limits of Callon's concept of 'discourse' by showing the historical intransigence of practices of governing. As discussed in Chapter 1, Callon's appropriation of the concept of discourse refers to the socio-material 'conditions

of felicity' under which statements are made true. However, I argue that the 'gaps' between statements – especially theories of consumer behaviour – and those socio-material conditions point to the need for a more historically sensitive understanding of calculability.

Emissions trading and electricity marketization: between neo-liberalism and sustainability

Throughout the 1980s, the marketization of electricity and other associated infrastructure took place in a number of jurisdictions across the globe with remarkable uniformity. By the late 1980s, traditional regulatory structures were seen to be inefficient and lacking legitimacy (Weale, 1992). In states such as Australia, Britain, Brazil, Canada, Norway and India, economists capitalized on this strategy by unbundling and marketizing generation, high-voltage transmission, local distribution and retailing activities.[1] However, this chapter argues that despite international uniformity, the local justifications for reform were remarkably diverse and contingent. The details of these reforms are significant because they affected the construction of carbon markets later on.

Regulationist and sociological critiques of electricity marketization have tended to explain electricity reforms through what Callon (1998; 2009) refers to as an 'embeddedness' paradigm,[2] whereby 'social context' explains the emergence of marketized economic forms. Regulationist and sociological critiques of regulation often elide materiality. Rather, they use society as a framework from which technical and economic forms of government can be explained and mapped. Explaining the economic from the social has allowed them to chart continuities and shifts in regimes of regulation in different national and historical contexts.[3]

This chapter argues in a number of ways against the idea of a pre-existent society upon which the (liberal) economy has been imposed. Firstly, the chapter attends to the materially distributed nature of action across human and nonhuman elements. A material sociology perspective draws attention to the peculiar socio-material properties of electricity networks. Market design features, boundaries and dynamics thereby become visible in a way that 'embeddedness' perspectives obscure. For example, electricity industries have collective properties that render any marketization partial. The creation of tradeable units of electricity (such as 5- or 30-minute increments) relies upon agreed standards of service within that time. Marketization is partial because such agreed standards are mutually understood by participants, rather than traded according to the actual use of electricity. 'An electricity industry operates by

maintaining a continuous flow of electrical energy from generators to end-use equipment. Generators, network elements and end-use equipment all contribute to this goal by operating in a mutually dependent manner' (Outhred, 2003: 23). The mutual dependence of network services, generators and end-users shows that actors in an electricity market, such as electricity users and retailers, are *agencements* whose basis for action is dependent upon others in the network.

Any model of competition for an electricity industry abstracts commodities from the underlying reality of continuously varying energy flows and cannot fully capture the short-term mutual dependencies between industry participants (Outhred, 2003: 2). Under marketization, underlying questions of collective responsibility for the quality of service of commodity units of electricity have shifted from the often-implicit responsibility of state agencies to formalized quasi-autonomous governing bodies (e.g., Braithwaite and Drahos, 2000; Outhred, 2003; Outhred, 2004). Furthermore, the gap between what is commodified and what is socially demanded means that the marketization of electricity supply has necessitated the development of new monitoring devices and institutions to protect the economic and socio-technical goals of availability, quality of supply and the legal liability for unsatisfactory delivery of energy services (Outhred, 2003: 2).

A key achievement of Actor-Network Theory, especially in recent years, has been to expand conceptions of politics beyond the realm of human interests and emotions to nonhuman actors. The concept of 'quality of supply' is exemplary here because it implicates social expectations and technical necessities. Certain consumer devices, such as televisions, make the quality of electricity supply visible: 'Nobody noticed if the bread took longer to toast because ... the voltage [dropped to] 160V rather than the promised 240V, but low voltage shrank the size of the TV picture' (Wilkenfeld and Spearritt, 2004: 97). In other words, the distinction between poor and adequate supply is a function of the technical characteristics of generation and distribution technologies and consumer choices – it is not reducible to social factors as 'embeddedness', as many regulatory accounts imply. The television becomes a political actor in assessing electricity supply quality.

Secondly, governmentality and material sociology perspectives share a concern for the way power is exercised by enrolling human and nonhuman actors into a common goal (such as emission reduction) through political and economic theories. Theories and discourses have an important role to play in unifying or dividing actions. As Callon has argued 'a discourse is performative if it contributes to the construction

of the reality it describes' (Callon, 2007b: 316). Discursive and rhetorical effects become visible when conflicts between economists, both 'confined' and 'wild', play out in market design processes. The more heated such conflicts become – 'hot situations' in Callon's terms (1998: 11) – the more obvious it becomes that calculability requires stable representations of ownership and representation that may not be agreed by all market participants. 'Hot' disputes about overflows, measurement effects and sources reflect the way framings are 'political and strategic battle-lines – over liabilities, profits, ethics and political interests' (Slater, 2002: 235). Thus, rather than mapping the economic separately from the social, Callon draws attention to the way 'markets trigger matters of concern' (Callon, 2007a: 139) as strategic games of calculation prompt reaction and resistance.

The politics of electricity marketization in Australia

The conflicts between discourses of neo-liberalism and sustainability over electricity marketization and greenhouse-gas emissions exemplify Callon's argument that framing is the site of strategic games for market participants. These tensions have been eased where rules of electricity market competition were developed that recognize the pollution externalities from fossil-fuel combustion. Thus, rather than operating as an alternative to neo-liberalism, sustainability has commonly provided a focal point around which the scale and boundaries of electricity commodities have been contested.[4] The restructuring of electricity markets in the 1980s included ecologically sustainable development goals in some places but not in others. For example, electricity restructuring in the United States and Denmark included industry assistance for wind farms by accommodating pricing and planning rules to encourage their development (Lyster, 2005).

One measure of the success of sustainability goals in the face of electricity marketization has been the recognition of the distributed nature of market power across participants in networks. Rather than conceiving of regulation as a measurable event with a clear beginning, as in Stigler's neo-liberal account, successful renewable energy policies have recognized that biases towards existing generation facilities are often built into prevailing market rules, generation infrastructure and end-use appliances (Healy and Kuch, 2008; Diesendorf, 2011)

In Australia, the two processes of electricity marketization and sustainability were kept well apart, much to the chagrin of participants in the Ecologically Sustainable Development (ESD) working groups establishing

during the early 1990s by the federal government. Neo-liberal advocates of electricity privatization and those concerned with sustainability sought to disentangle the market in electricity in opposing ways. For neo-liberals, state-run power generation was inefficient in ways the market system could solve, whereas for ESD advocates a market for electricity was wrong-headed, would lead to perverse outcomes and needed to be disentangled from energy end-use services such as those of heating, power and cooling (Diesendorf, 1996). The electricity market rules were shaped by these discourses in response to three issues: (a) the promise of markets to provide more efficient greenhouse outcomes than would be achieved by regulation; (b) excess generation capacity from speculation about a minerals boom; and (c) the potential for state debt. These are examined in turn below.

The neo-liberal programme of governing electricity supply through market efficiency was governmentalized through institutions centred on setting a price that includes only the direct costs associated with the production inputs of electricity. The fact that the National Energy Market rules contain no explicit environmental, sustainability or greenhouse considerations reflects the success of neo-liberals in translating competition principles into governing rules.[5] The mitigation of greenhouse gases was considered an unnecessary additional set of demands upon supply rules (Pearse, 2007). Markets, it was asserted, would provide a more efficient outcome than regulation.

However, this victory was pyrrhic: what neo-liberals thought they had gained from the decentralization of economic choice through marketization was 'lost' through growing concerns about the environmental impacts of industrial expansion. Rather than subsuming the social into the economic by allocating private property rights, the competitive market in electricity created new concerns about greenhouse gases. Concerns about the rejection of any integration of greenhouse-gas mitigation goals into electricity market rules eventually saw the NSW Greenhouse-Gas Abatement Scheme come into being.

Electricity marketization was part of a competition reform agenda which sought to tear down what were previously held to be 'natural monopolies' in electricity, water, rail and gas provision within the welfare state. The architect of these reforms argued that improving the efficiency of these sectors remained a national priority (Hilmer et al., 1993). From the post-World War II period through to the early 1990s, the Australian electricity industry consisted of large, state-based, state-owned utilities.[6] However, as in England, they became 'victims of their own success' (Evans et al., 1999) as questions arose about the need for

the infrastructure investments they proposed. In Australia, the transformation from public utilities into corporations[7] began in earnest with the first Council of Australian Governments meeting in 1990. Competition policy was designed to transform infrastructure from a site of corruption and speculation into an economically efficient arrangement.

The neo-liberal justifications for marketization were most clearly presented as a justification for reform when industry leaders and politicians met to 'establish the National Grid Management Council (NGMC) to encourage and coordinate the most efficient, economic and environmentally sound development of the electricity industry in eastern and southern Australia'.... (anon, 1997). These economic principles were intended to remediate 'the costs to the nation ... in terms of excessive generation capacity, inappropriate plant mix and inflexibility of fuel use' (anon, 1997). The Industry Commission estimated that the surplus generation capacity in NSW alone in the financial year 1989–1990 had an annual opportunity cost of $443 million (Owen, 2009: 570). This opportunity cost estimate of the 'environmental benefits' of a market mechanism was presented as a policy that would prevent excessive investment in generation capacity.[8]

The neo-liberal attack on 'excess generation capacity' referred to a second factor contributing to electricity restructuring: the bursting of a speculative bubble of state-financed generation infrastructure motivated by the potential of attracting resource investment through heavily subsidized power. Running parallel to the restructuring of textile and manufacturing industries through tariff deregulation had been a program to construct new power stations. This commenced in the early 1980s at the urging of state and federal governments based on the prediction that there would be a 'resources boom', based primarily upon aluminium smelting (Diesendorf, 1996: 35; Wilkenfeld and Spearritt, 2004: 82). In an interview with Pearse (2009: 26), one former energy policy official stated:

> [W]hen we were talking about energy market reform, breaking up the electricity market and reforming it, the view was that we had to drive energy prices down and consumption up. [Q: Consumption up?!] Well, I mean, so we would attract energy intensive industries and therefore increase consumption. Yes, basically make Australia the homeland for footloose capital that required cheap energy – aluminium and so forth. And therefore we expected to see increased consumption of energy because that was our comparative advantage. When we went through the whole reform process, there was an

> attempt [by others] to get in there that there had to be a lot of fuel switching and greenhouse considerations [the ESD process] and that prices should actually reflect carbon and all that. That was effectively removed by Keating.

This boom never eventuated so, by the early 1990s, an additional driver of reform emerged – state debt. State governments wanted to sell off their assets to control debts that were emerging from burgeoning electricity supply infrastructure costs.[9] Both New South Wales and Victoria ran enquiries into the generation planning failures that almost bankrupted their states. In 1985 Gavan McDonell was appointed by the Wran government as Sole Commissioner into an Enquiry of Electricity Generation Planning in New South Wales. This commission examined operational and planning failures and issues in the electricity industry in New South Wales and Victoria in the early 1980s. McDonell's report resulted in the abandonment of proposed coal-power stations valued at $12 billion, led to the restructuring of the state's power monopoly utility and contributed to the justification for a national grid on the basis of economic efficiency.

Contesting the National Electricity Market

Stigler's neo-liberal arguments against regulation were repeated by proponents of competition policy in Australia. The rules of the electricity market were shaped according to competition policy, which aimed to transform infrastructure from a site of corruption and bureaucratic speculation into an economically efficient arrangement. However, the proposed reform was contested by advocates of sustainability. They argued that neo-liberal post-hoc rationalizations of economic efficiency were conflated with the concepts of sustainability embedded in the federal government's ecological sustainability process.

The diverse political exigencies of planning failures led to the large, vertically integrated and discrete state-owned electricity networks being corporatized in some states and privatized in others, then amalgamated into a national wholesale market over the course of the 1990s. At the end of the 1980s, the state electricity authorities – unified by the micro-economic principles of national competition policy – were transformed across the country into over 30 state or privately owned major power-generation firms, which two decades later encompassed over a hundred coal-fired power plants (McDonell, 2008). Retail electricity prices fell by an average of about 25 per cent in real terms during the first years of

marketization, and direct employment in the industry was halved over the 1990s (Outhred, 2004). Governing arrangements for the National Electricity Market were based on a number of market principles.[10] One of the underlying principles of marketization was the decentralization of decision-making. As Outhred explains,

> centralised decision[-]making would pre-empt the commercial discretion of market participants and distort market outcomes. Therefore the National Electricity Market (NEM) is designed as a 'simple' spot market, in which the spot market for each interval is solved independently of all other spot market intervals. Centralised forecasts of future prices are made, however[,] most responsibility for decision-making rests with participants. For example, decisions to start or stop generators (commitment or de-commitment decisions) are left to market participants. (Outhred, 2000: 115)

The deliberate omission of greenhouse principles from this competitive market – in which 'environmental effectiveness' was justified on the basis of marketization alone – saw environmental campaigners direct their efforts elsewhere. Working with newly elected Greens members of Parliament, civil society groups and campaigners formulated initial attempts to impose competitive greenhouse-gas reduction benchmarks on greenhouse-gas emissions in NSW, detailed below.

The environmental efficacy of competitive electricity markets was contested in terms of micro-economic principles in two main ways: firstly, through reforming market rules and introducing new regulations; and, secondly, by resisting state regulation. Environmentalists promoted Ecologically Sustainable Development via the language of micro-economics by discussing how greenhouse externalities of power generation could be managed most efficiently. The promotion of ESD fed into the federally sponsored workshop that produced the first National Greenhouse Response Strategy.[11] Promoters of greenhouse-gas mitigation embraced the language of microeconomics, arguing that internalizing externalities would produce more economically sustainable electricity generation. For example, Diesendorf (1996) argued that 'a large potential for implementing cost-effective energy efficiency measures' was held back by 'market barriers'.[12] Secondly, engineers and political economists argued that electricity privatization operated as a class project to divest risk from capital onto the state, thereby eroding the reliability of supply and the safety of generation (Beder, 2003; Cahill and Beder, 2005a; Cahill and Beder, 2005b).

These perspectives have a common interest in showing how the rules have favoured the largest, cheapest facilities at the expense of new entrants (Cahill and Beder, 2005a). American analysts have documented a similar dynamic in the United States (Tomain, 2002). The implementation of the NEM led to a large increase in brown coal–fired generation from the Latrobe Valley in Victoria because it was the cheapest; hence, it dispatched power first (Hamilton and Denniss, 2000). As a result of the implementation of the NEM alone and the increased demand for the Latrobe Valley brown coal–fired generators, Australia's greenhouse-gas emissions increased some 10 per cent in the year the NEM began (Hamilton and Denniss, 2000). This increase was part of a broader trend: between 1990 and 2006 the Australian government reported a 47 per cent increase in emissions from its stationery energy sector and a 27 per cent increase in transport emissions, despite the introduction of the National Greenhouse Response Strategy and the NSW Greenhouse Gas Abatement Scheme.

The neo-liberal doctrine is exemplified by Beardow and Schaap (2000) of the Electricity Supply Association of Australia. They echoed Stigler's *post-hoc* rationalization of the efficiency of markets to claim that 'transparent markets [promoted] cost-reflective pricing and energy efficiency'. The filtering of the 'nonsense' of civil regulation, that Foucault (2008: 247) recognized as a neo-liberal trademark, is reflected in the assertion that 'environmental performance' was 'integrated into most aspects of business decision making' and, thus, 'businesses embrace industry self-regulation in relation to environmental management because it can deliver superior business and environmental outcomes' (Beardow and Schaap, 2000). The accusation that regulatory actions are inferior to and discrete from markets is most explicit here.

Government support for industry self-regulation extended to the federal level during the 1990s (Pearse, 2007). Thus, towards the end of this decade, proponents of climate-change mitigation policies criticized the steering committee of the National Greenhouse Response Strategy (NGRS) for 'misapplying' the ESD principles in formulating a greenhouse strategy (Bulkeley, 2001). Eckersley, a proponent of 'ecological sovereignty' and a participant in the ESD process, argued that there was 'a clear failure to link the principles of ESD to policy measures and strategy formation in the NGRS' (cited in Bulkeley, 2001). In 1995, the first independent review of the NGRS found that 'after two years of its operation, there [was] no evidence that even one tonne of carbon emissions has been saved as a result of the NGRS' (Wilkenfeld et al., 1995: 1). For many participants, the ESD consultation process proved to be a fig

leaf for the further expansion of resource-extraction interests (Lafferty and Meadowcroft, 2000: 25–26; Diesendorf, 1996; Pearse, 2009)

GGAS Part 1: Contesting baselines, framing actors

The GHG emissions benchmark for NSW emissions reductions ostensibly resembled a 'cap' in a cap-and-trade scheme because reduction targets were calibrated against it. The electricity retailer benchmark was 5 per cent below the 1989–1990 per capita level (NSW) by the year 2000–2001 (DEH, 2011). The benchmark was part of the retail license conditions for the newly created corporate electricity retailers under the Electricity Supply Act (1995).

The benchmark was imposed on retailers, rather than on generators, and for three main reasons: firstly, retailers were within the constitutional reach of the NSW government, unlike the generators, who participated in a national market;[13] secondly, retailers had access to end-use customers, and hence scope to undertake activities such as end-use energy efficiency; and, finally, because retailers had some influence on investments in generation technologies and the sequestration of carbon dioxide, and they could sell 'competing'[14] fuels such as natural gas and electricity (Outhred et al., 2002). The benchmarks were hoped to incentivize retailers to develop strategies to sell fuels that are less carbon-intensive.

Because retailers rather than generators were regulated, the quantification of emissions reduction could not rely on publicly disclosed measurements of emissions as with the US sulphur scheme. The NSW GGAS and the 'benchmarks' scheme that preceded GGAS were distinctive insofar as credits were generated by the *absence* of power-station emissions, rather than permits allocated and traded with reference to an agreed cap (as with the US sulphur scheme). For expert observers, the use of the concept of a 'benchmark'[15] – that is, something that can be witnessed – to refer to an absence represented a paradox of using something visible to measure something that was an imputed absence, that had not even come into being. This paradox represents an important point of difference between cap-and-trade and baseline-and-credit emissions trading schemes. Emissions 'caps' are based on an agreed level of emissions, whereas credits are allocated according to the judgement of experts.

Thus, expert judgements were required to assess the plans to improve energy efficiency that retailers were required to devise as part of their licensing conditions. These plans were the basis of claimed emissions

reductions of 5 per cent per capita against the benchmark. However the plans were abstract, rather than factually verifiable, as the term 'benchmark' indicated. The only legislated requirement was that the implementation of the plans be audited by the NSW EPA at least once every three years (Nolles et al., 2002: 4).

The crucial difference between baseline-and-credit and cap-and-trade is their respective reliance upon measurement of counterfactual and physical emissions. Whereas an entire new metrological apparatus was established for the sulphur permit trading scheme based on the continuous monitoring and disclosure of emissions, the NSW regulators adapted existing greenhouse emission calculations (explained below). The underlying architecture of emissions calculations has remained largely unchanged in NSW from the commencement of benchmarks under the 1995 level through to the introduction of mandatory benchmarks discussed below. Although a mandatory baseline-and-credit system was to evolve from these benchmarks, they share a common origin in their reliance on expert judgements about counterfactual emissions.

These judgements were contentious, both because of their counterfactual nature and the opacity of emissions calculations used to claim that reductions had been achieved. Due to the competition rules framing the electricity market, accurate measures of physical emissions associated with electricity production were not publicly disclosed.[16] Rather, a methodology was built which attributed emissions, based on aggregated changes in emissions of a 'pool' of generators, relative to a baseline. As the engineer 'economists in the wild' argued, to borrow Callon's phrase 'the main performance indicator of the NSW scheme is not measuring actual emission reductions but rather an artificially constructed imputed emission reduction indicator' (Outhred et al., 2002: 7).

State agencies were given the task of collating, calculating and attributing these emissions and changes. However, the economic imperatives of electricity market competition meant that the decisions crucial to demonstrating a reduction in emissions above what would otherwise have occurred needed to be taken on trust, rather than demonstrated publicly. Before these are outlined, however, some political context is necessary to understand how the original attempts to impose greenhouse benchmarks on the industry, following the 1995 NSW election, were transformed in the NSW GGAS.

The politics of 'voluntary' benchmarks (1995–2002)

The narrow[17] Labor victory in 1995 meant that the government of the newly elected Premier Bob Carr would need to negotiate with

newly elected Greens legislative councillors in order to implement his reforming agenda. Carr was a charismatic leader with reforming zeal, referring to himself as a 'fellow New Dealer' in reference to the ambitious social agenda of US president, Franklin Delano Roosevelt (Carr, 2008). The core reform to be undertaken by Carr was the implementation of the National Competition Policy, which sought to create 'markets and competition within them by following agreed competition principles and the extension of the Commonwealth's Trade Practices Act (TPA) to State and Territory Government business and unincorporated business activities to fully regulate those markets' (Hendy, 1995). This was the first move towards privatizing the electricity supply, underpinned by the conviction that, rather than being threatened by damaging union campaigns about job losses, governments could achieve their objectives via regulation. As Carr stated to me in an interview:

> If you can use the Reserve Bank to regulate the private trading banks you don't need to take them under public ownership. That was my argument, and it was really won in Labour Party circles both here and overseas.… No-one doubted our capacity to put restraints on private ownership in the context of the building of the National Electricity Grid. (Carr, 2009)

The imposition of greenhouse emissions benchmarks on recently created electricity retailers were negotiated by the newly elected NSW Greens with the hope that they would make Carr's reforms compatible with regulation. Meeting these benchmarks would be a condition of retailer license conditions. The newly elected Greens politicians hoped that the regulations would enhance environmental and profit outcomes and ease tensions between the goals of sustainability, reduced greenhouse-gas emissions and the efficient allocation of resources promised by marketization. However, the extent to which the benchmarks came to be known as 'voluntary' would reflect the fragility of the negotiations between Labor and Greens and the difficulty of imposing additional costs on newly formed electricity retailers.

Negotiations between the Greens and Labor over electricity reforms resulted in a proposal to split the state utility into three components: (a) generation; (b) transmission; and (c) distribution and retail. The Greens were concerned that the movement towards privatization would compromise the ability of the government to restrain greenhouse-gas emissions, so they negotiated two deals to allow the passage of the bill: the creation of the Sustainable Energy Development Authority

(SEDA) and the limiting of greenhouse emissions through a benchmarks scheme.

These initiatives echoed the Porter Hypothesis (1991): environmental and economic goals would be aligned if legislatures moved first to impose regulation. This vague, explicitly performative notion, in which the interests of capital and society would inexorably align – the question only being who would accrue the advantages of moving first – was instilled in SEDA's mission statement: '[D]elivering greenhouse gas reductions, environmental, economic and social benefits to the NSW community by accelerating the transition to sustainable production and use of energy' (SEDA, 2004: 2). This would be achieved primarily through 'market transformation … where the majority of investors and consumers routinely adopt sustainable energy technologies and services, for the economic and environmental security they provide over conventional energy supply' (SEDA, 2004: 2). SEDA's programs targeted both households and businesses to enact this transformation. They developed a Green Power initiative, household rebates for solar hot water and the Smart Energy Business Program (whose clients included major hotels and CBD firms) delivering some $6.3 million in savings on power bills (Angel, 2008: 137).

Expert assessments of the benchmarks raised a number of questions associated with the factual status of emissions-reductions claims mentioned above. These questions related to scheme rules and stringency, its relationship to federal policies and the influence of neo-liberal economic techniques to bring the structure and costs of regulation under a market purview. Firstly, discussions with retail managers and government departments revealed confusion about the eligible activities that retailers could implement and report (Nolles et al., 2002: 6). The benchmarks were non-binding, and retailers were only required to submit strategy plans; however, as Nolles et al. (2002: 6) explained:

> No requirement existed that a strategy plan had to target meeting the benchmark. In the extreme, a strategy plan could thus in fact target NOT reaching the benchmark, and a progress report could then state that (as planned) no progress towards the benchmark had occurred, and this would still be considered 'compliant' by the Ministry of Energy and Utilities.

Secondly, it was not clear that retailer influence on generation investment decisions was as significant a factor as the 'Porter Hypothesis' implied. Rather, the theory of competition that influenced electricity supply

decision-making conformed to a regulation-minimizing ideology that echoed Chicago school neo-liberalism. As one interviewee explained:

> the difficulty was, as I used to say, it was like the tail wagging the dog. The requirements were on retailers not generators, the theory behind it – the view was that if you were to regulate generators as a whole, across the state, you'd actually impose a competitive disadvantage on NSW generators. That would lead to a perverse outcome, market shifting to Victoria … as it did [with Victorian brown coal–generation taking over primary dispatch].[18]

Furthermore, the economic security imperatives of the NEM also signified that the threat of suspending retail licenses was largely perceived to be an empty one (Moran, 1996). This meant few companies devoted resources to fulfilling their requirements, expressing little confidence in the proposition that competitive advantages may accrue, as per Porter's Hypothesis. One interviewee suggested, 'there was no way [the secretary of treasury (a former economist with the corporatized generator Pacific Power)] was going to let us slip some dodgy policy [–] if we were going to have [benchmarks], we were going to have them in an economically sensible way'. However, what was 'economically sensible' became a complex set of rules and calculations based on arcane expert judgements, rather than the streamlining of government to which neoliberals were ideologically committed. The exclusion of the costs associated with greenhouse-gas emissions from the immediate calculation of electricity costs was reintroduced in increasingly complex ways.

The politics of calculating the near future: Electricity Sales Forgone

The Electricity Sales Foregone (ESF) rules exemplified the controversial role of expert judgement in assessing retailer compliance with greenhouse benchmarks. Whereas the emissions reductions in the US sulphur scheme attained the status of facts through the implementation of continuous emissions monitoring systems,[19] the abstract nature of counterfactual judgements about electricity sales strategies prevented NSW emissions reductions from achieving an equivalent factual status. These judgements were based on unverifiable collations and abstractions. As MacKenzie (2009b) emphasizes, market design is a political matter. The politics of deciding whether or not greenhouse costs should be included or excluded in estimates of the benchmark was a determining factor in devising the regulations that would become the New South Wales emissions trading scheme.

The NSW scheme was built on the use of 'emissions factors' that were reported nationally as required by National Electricity Market rules (MEU, 2000). Emission factors were 'used to indicate the quantity of greenhouse gases emitted due to the combustion of a unit of fuel (measured in energy terms)' (NGGIC, 2006: 69). These factors were based on fuel data supplied by power-station operators from 1988 to 1995 to the National Greenhouse Gas Inventory (NGGIC, 1996) and multiplied by electricity sold by the newly incorporated retailers. In the NGGIC's 1996 published report, missions reductions were attributed on the basis of these emissions factors.

Electricity sellers protected their competitive positions by lobbying for concessions from the NSW government, just as generators had done in the US Sulphur Permit Trading Scheme.[20] In NSW, the ESF rule was developed 'to compensate generators for the loss of revenue from retailers who considered helping their customers either to become more energy efficient or to generate some of their own electricity on their premises' (EPA, 2002). For example, if an electricity retailer were to audit a factory's energy use and recommend upgrading an electric boiler with an efficient gas one, they would lose the sales of electricity. The EPA audit argued that:

> Electricity Sales Forgone was developed as a policy mechanism to offset this disincentive. The effect [was] that a retailer who had conducted activities giving rise to ESF obtains a higher benchmark, which allows it to sell more electricity under the benchmark than would otherwise be the case. This enables retailers to compensate for the lost revenue resulting from providing a service to customers that reduce GHG emissions. (EPA, 2002: 11)

However, 'lost' sales cannot be measured. They can only be estimated. And in the case of ESF, the 'benchmark' could not be separated from potential investment decisions. Bureaucrats attempted to guard against accusations of arbitrariness by extrapolating estimates of electricity sales 'forgone' from market share. These extrapolations became the basis for allocating credit for Electricity Sales Foregone. As the EPA audit stated, '[This] definition of market share assumes that all claims for ESF are equally valid, and of an equivalent value (in unit terms) to electricity sales' (EPA, 2002). Such methodologies are spurious because they are based on estimates rather than measurements, even though these estimates were given the status of measurements, as the term 'benchmarks' indicated.

However, it became clear to observers that retailers were using ESF to pursue their own commercial interests. For example, the rules permitted the 'deeming' of quantified emissions reductions from retailer spending on advertisements promoting energy efficiency to their customers (MacGill et al., 2003: 33). This concession meant that greenhouse gas reductions against the benchmark were claimed against estimates of the efficacy of advertising, again something that could only be estimated rather than measured. The speculative, counterfactual nature of ESF saw retailers claim more credit for emissions-reducing activities than was anticipated by the regulator. Although SEDA sought to establish a set of rules about what activities could or could not gain credit, an audit found that 'retailers do not appear in general to be meeting these minimum reporting requirements for ESF claims' (EPA, 2002: 14)

In the final period, 2000–2001, only two retailers achieved their benchmark emissions level, whilst the remaining 20 exceeded the benchmark by an average of 15.5 per cent due to the inability of the regulator to conclusively establish plausible facts about Electricity Supply Forgone with retailers (EPA, 2002). Outhred (2002: 5–6), a member of the Licence Compliance Advisory Board, and who oversaw the retail licence conditions notes that during the life of the scheme no penalties for non-compliance were imposed on any retailer because they set themselves goals that would ensure minimal need to disrupt their core business of selling power in the newly created, highly competitive market. These criticisms foreshadowed the introduction of mandatory benchmarks for the retailers.

GGAS Part 2: Mandatory benchmarks (2003–2008)

Mandatory benchmarks were designed to force a market for carbon offsets into existence in the belief that marketization would reduce the state's per capita emissions. As the manager of the GGAS, David Hemming stated, 'politically, [government] had the choice of bailing out or putting teeth in [the voluntary greenhouse benchmarks scheme]. They decided on the teeth' (Hemming, 2009). After being re-elected in 1999 with an increased majority, Labor was in a position where any legislative changes did not require further negotiation with the Greens and could be made on Carr's own terms. After some consultations in 2002[21] the legislation, regulations and rules were finalized in January 2003.[22] The energy minister's chief of staff at the time noted:

> We wanted a scheme that was going to first and foremost reduce greenhouse emissions. A reduction in emissions over business as

> usual – and it's very hard to assess business as usual – and one that did so at most efficient cost. We already had a lot of programs of Government picking winners. Sometimes they don't provide the most efficient outcomes. For [Energy Minister Yeadon], it was 'let's deal with all the low hanging fruit first', then we can move up the scale. (Baumgartner interview)

Three aspects of these reforms are notable insofar as they illuminate the translation of the goal of emissions reductions into a more abstract goal of maintaining economic efficiency against counterfactual scenarios. Firstly, the introduction of mandatory certificate-based trading formally created credits through enforcement provisions. With the creation of a distinct set of rules for the generation of emissions-reduction credits, the question became one of arranging these provisions, objects and agents with potential rules for offset provision: new energy-efficiency credits, tree plantations and other credits each involved complex challenges for regulators.

Secondly, the baseline year of emissions from the NSW 'pool' of generators was reset to 2002. This decision was politically contested, as it was equivalent to loosening the cap in a cap-and-trade scheme. Baselines and caps are intended to indicate factual agreement about the basis of emissions reductions. In Callon's (2009) terms, loosening the cap or shifting the baseline against which reductions are measured without collective reflection, consultation and agreement, indicates a gross failure in the civilizing experiment of carbon trading.

Hemming (2005) argued that the reset was necessary to make up for the shortfall produced by non-compliance with the previous voluntary benchmarks scheme. This resetting of the baseline also accommodated new gas-fired power plants that had come online in the intervening period. However, Passey et al. (2007) argue that the resetting of the baseline simply created further windfall profits for generators who gained credit for building plants that would have gone ahead regardless, further diminishing the incentive to invest in renewable energy generation. Another effect of this decision was to further insulate existing coal-fired plants from more direct regulation by making their compliance easier and raising the barriers for renewable energy generators to enter the market.

Finally, the scheme also introduced a special arrangement for large energy users.[23] Penalties for non-compliance (Rule 1) were set at double the certificate price. The compliance role would no longer involve the Environmental Protection Agency as an independent auditor. Instead,

the Independent Pricing and Regulatory Tribunal (IPART) – which had administered[24] the voluntary benchmarks in its roles as the 'independent body that oversees regulation of the water, gas, electricity and public transport industries in New South Wales'[25] – also took on the role of monitoring, compliance and enforcement. The License Compliance Advisory Board, the four-member board[26] that reported on plans by retailers to reduce their emissions under the original deal to pass the 1995 legislation, was dissolved as the details of the mandatory benchmark scheme were negotiated in 2000. This decision further undermined the collective nature of reflection, consultation and decision-making upon which experiments with carbon trading proceeded. IPART now became solely responsible for ensuring that greenhouse emissions were reduced. Trust in IPART as both administrator and auditor, and trust that these two functions were quarantined one from the other, were the ultimate basis of claims that emissions were being reduced in NSW.

Making and marketing emissions reductions

The ability to 'make things the same' (MacKenzie, 2009a) underpins the promise and challenge of creating successful carbon markets. MacKenzie has documented two aspects of this process: how choices involved in classifying emissions rights have been institutionalized by accounting organizations, and how greenhouse gases are made commensurable through 'big-science' atmospheric experiments, embodied in IPCC reports and used in economic calculations. This work shows that carbon offset production is not reducible to trade-offs and choices as economists such as Fischer (2005) have argued, but requires both technical coordination and institutional authority. However, specific state rationalities are absent from MacKenzie's analysis, which spreads agency across socio-material *agencements*. Even in Callon's call to 'civilize markets' the state is absent. Governmentality studies have emphasized the way expert authority has been necessary for securing liberal forms of government (Dean, 1991; Rose, 1993; Barry, 1996; O'Malley, 2000). As Rose suggests:

> Political forces seek to utilize and instrumentalize forms of authority other than those of 'the State' in order to govern – spatially and constitutionally – 'at a distance'. They act to accord authority to expert authorities whilst simultaneously seeking to secure that autonomy through various forms of licensure, through professionalization and through bureaucratization. From this time forth, the domain of

> liberal politics will be distinguished from other spheres of authoritative rule, yet inextricably bound to the authority of expertise. (Rose, 1993: 292)

The previous chapter documented the 'licensure' of acidic emissions and professionalization of civil expertise. Bureaucratization went hand-in-hand with the construction of socio-material devices to measure, quantify and calculate acid-rain emissions. However, the competition imperatives of the National Electricity Market forbade NSW regulators from imposing sulphur trading-like continuous emissions monitoring systems on power plants and publishing the readings. This meant that civil actors needed to trust state regulators. The benchmark scheme's regulator, the Independent Pricing and Regulatory Tribunal (IPART), received confidential data on the quantity of fossil fuel burned in major New South Wales power stations in line with the National Greenhouse Inventory referred to above (NGGIC, 1996), then published a 'pool coefficient' for the state as 'an indicator of the average emissions intensity of electricity sourced from the electricity grid in NSW' (anon, 2010: 1). Thus, power station operators and the National Electricity Market regulators' information on power dispatched provided the data used to calculate the state emissions baseline. Appendix A details the pool calculations; however, the key elements are as follows: the pool was devised based on reported historical emissions from the power stations in New South Wales, then averaged to 'smooth the impact of any one-off highs or lows in the [pool value] in a particular year[,] ... thus mak[ing] the NSW pool coefficient more stable and predictable' (anon, 2010: 1). This imperative of 'stabilizing and making more predictable' conformed to competition and economic cost imperatives in that it made it more difficult for competitors to gain commercially sensitive information on the supply chains of power stations.

Although electricity retailer input was only one factor in generation investment decision-making, retailers could purchase carbon offsets. Carbon offsetting demonstrates the success of 'economists in the wild' in translating the goal of direct emissions reductions into goals of maintaining economic efficiency. Recent work on carbon offsets has demonstrated the historical path dependencies and material actors involved in this work of translation. Geographers have looked beyond the world of policymakers and their social networks and, instead, examined how offsets are materially structured (Lovell and Liverman, 2010). The silviculture and energy-efficiency offsets demonstrate the value of combining material sociology and governmentality perspectives. For these offsets to

be successful, a variety of human and nonhuman actors must be aligned with the goal of demonstrating a quantified reduction in emissions.

IPART's final reports on NSW GGAS before the scheme was folded (2009) show the number of New South Wales Greenhouse Abatement Certificates (NGACs) created under each rule. The certificates represent one tonne of greenhouse gases avoided against a complex counterfactual baseline calculation for state emissions, in the case of generation,[27] or the satisfaction of other rules laid out by regulators for biosequestration and demand-side abatement. Generation certificates were the highest, with almost 13 million created to 2007, followed by 10 million Demand Side Abatement Certificates.

Governing forests

Approximately 2 million NGACs were created under the 'biosequestration rule' (Rule 5) between 2003 and 2007, almost exclusively by the corporatized government body, Forests NSW. This was around half as many as Easy Being Green created for giving away and installing efficient light bulbs, a scheme discussed below. Like the Demand Side Abatement rule, under which Easy Being Green created their credits, the silvicultural practices and inscriptions upon which the biosequestration rules function originated in crises.[28] The success of silvicultural biosequestration offsets was attributable to a range of human and nonhuman actors mobilized for the goal of demonstrating long-term ownership over a quantified carbon resource according to international carbon accounting rules.

This demonstration of ownership and 'permanence' was not simply a matter of economics, but indicated a deep relationship between expert resource management authorities and modern government. The possibility of biosequestration carbon offsets grows from the mutual constitution of the normalization of timber supply, its accountability and the government of economic life by civil experts.

Silviculture was considered a 'state science' par excellence along with police science at the time of the founding of modern states (cf. Foucault et al., 2007). However, Foucault focused his attention on population and liberalism, at the expense of other state sciences. Governmentality scholars have developed sophisticated analyses of Foucauldian insights by examining the role of economics and accounting in managing populations (Miller and Rose, 1990; Kurunmaki et al., 2010). However, while silviculture and cameral government[29] were born together, forestry science has been largely overlooked in the biopolitics and science studies

literature. An analysis of silviculture can show how modern government, expertise, and its supporting infrastructure emerged and evolved together. So, an historical excursion will be useful at this point.

An administrator of Saxony's mines, Hans Carl von Carlowitz wrote *Sylvicultura Oeconomica*, published in 1713, outlining principles of 'continuous, permanent and sustainable utilization'[30] in response to the resource-management demands imposed by seventeenth-century mercantilist reconstruction efforts after 30 years of war (Pretzsch et al., 2008: 1066). Timber was used as a building material to support mineshafts, and in many other applications. The early modern state emerged alongside practical methods of governing resources (Lowood, 1990: 326). Whilst civil expertise in atmospheric chemistry developed from the imperatives of nineteenth-century liberal Britain (as argued in Chapter 2), forestry scientists were necessary supporting actors for earlier forms of government. Eighteenth-century scientists and cameralists mutually reinforced the others' interests using quantitative techniques such as the annual accounting of resource-management based on 'scientific principles'. Forest scientists and government administrators were brought into alliances with one another through the need to devise a numerical inscription of the yield that a forest could bear over time. In German States, these inscriptions were recorded in *Geld-Etat*, or monetary budget, while *Forstwissenschaftler* (forestry scientists) utilized the *Forst-Etat,* or forestry budget of timber supply over forthcoming accounting periods (Lowood, 1990: 336). One prominent *Forstwissenschaftler*, Friedrich von Burgsdorf, developed the concept of *normalbaum* (normal tree) to reconcile the demands of administrative efficiency with the problem of inherent measurement error, cultivating and surveying uniform 'stands' as a form of *in vivo* experimentation that accommodated both these social and normalizing objectives.

Throughout the nineteenth century, particularly in Germany, sophisticated experiments with management, modelling and harvesting were developed that corresponded with the demands of cameral governments for predictable wood supplies. These included the publication of forest yield tables, whereby estimates of growth, height, biomass and other factors were recorded. Through such practices, cameralism grew into *Staatswissenschaften,* the 'Sciences of the State', which included forestry, police science and transportation. By the end of the nineteenth century, reformers of forestry in France, the United States[31] and the British colonies had developed professional forestry management institutions based on the quantitative reasoning of *Forstwissenschaft* (Lowood, 1990: 341).

This genealogy is important for two reasons. Firstly, it helps disentangle elements of the relationship between expertise and liberal rule integral to governmentality analysis. Foucault's (2007) analysis focused on *thinkers* – the British liberals, French physiocrats and American neo-liberals. This emphasis on thought was not on closed systems of reasoning, but on how thinkers took up particular historical problems and recast them as problems of thinking about the calculability of economic life. In Foucault's analysis, *laissez faire* government arises as an alternative to police science through a contingent set of economic events. The 'invisible hand' provides governing officials with a more efficient means of, for example, guarding against grain shortages than does tabulating grain supply and demand in physiocratic tables (Foucault et al., 2007). In this movement from control to *laissez faire*, the population emerges as the target of government whereby shortages in some areas is allowed as long as it enhances the aggregate welfare of the population. Governmentality scholars such as Dean (1991) have further argued that an economics arose to address the tension, identified by Malthus, between resource management and population growth. Silviculture shows that the relationship between government and the quantification, monitoring and expert control of resources predates liberalism. What was distinctive about the role of Robert Angus Smith within the Alkali Inspectorate in nineteenth-century Britain (analysed in the previous chapter) was Smith's claim to be acting in the public interest, whilst negotiating with industry and elected officials. The strength of governmentality analysis, then, lies in highlighting how the professionalization and bureaucratization of *civil* expertise, rather than expertise *per se,* was a necessary condition for modern liberal forms of rule (Rose, 1993).

Secondly, the history of silviculture blurs the implicit separation of contractual exchange and economic rationality on the one hand, from coercion and violence on the other, a separation which underpins conventional accounts of neoclassical economics (Mitchell, 2002). Markets are often presented as the apotheosis of Enlightenment and a solution to unruliness and conflict (Blaug, 1997). However, territorial sovereignty, which might require violence – such as the violence of exclusion to establish it – is a precondition of modern government (Foucault et al., 2007; Dean, 2007). The significance of *civil* expertise lies in articulating limits to sovereign power by enclosing civil society within a territory (Dean, 2007). In practice, this meant that the development of a scientific discipline premised on making the internal structure of forests commensurable with the fiscal demands of the state required that untrained locals and indigenous populations be excluded from the

forests. These exclusions led to some violent clashes between police and local communities seeking access to timber resources (Hölzl, 2010). Such clashes were the basis of what Marx called 'the expropriation of the peasantry', and what Polanyi in the 'Great Transformation' referred to as the emergence of new forms of property from which wage-labour would develop (Dean, 2007: 141).

This early history of silviculture is especially important considering the modern-day spread of forestry-based carbon offsets through global mechanisms such as the Clean Development Mechanism (discussed in Chapter 5) which were developed as a 'flexible', market-like mechanism. Silviculture's origins are also important in understanding the evolution of the relationship between governmentality, expert judgement and neo-liberalism. Following Callon, this analysis draws attention to the way developing new markets in carbon offsets requires calculative devices to exclude existing inhabitants and users of forests; however, it also draws attention to an historically specific relation between the state and such devices – a connection that is absent in Callon's account. For Dean (2007: 148) the sovereign power to decide life and death (broadly defined) was not simply replaced by the territorial nation state; law, state, nation and sovereign power are characterized by 'shifting, rather than fixed relations'. The creation of new carbon offset categories and rules to frame the carbon in forests, thereby excluding contemporary indigenous populations,[32] expresses such shifting relations.

Calculating the distant future: biosequestration and the 100-year rule

The techno-political negotiations of the biosequestration rule exemplify the complex, cumbersome *agencements* necessary to make emissions permits calculable and exchangeable. The chief advantage of the concept of *agencement* is that it shows how action is distributed across heterogeneous elements. In Callon's account, the distinctiveness of marketable goods (as opposed to gifts) is not just the social relations of buyer and seller – relations that are demarcated by exchange – but that claims of ownership must also be demarcated through socio-material frames. These frames include all the intermediaries that allow parties to exchange contracts and exclude claims to ownership from others; hence, the need to make the NSW State Forests 'pool' of trees a singular, calculable economic entity.

To tame the uncertainties of tree production, policymakers under the guidance of NSW Energy and Forestry Minister Kim Yeadon drew up a series of rules by which electricity retailers could become eligible to

receive credits. These demarcated relations between forest managers and the economic administrators of the state, which not only require trees to remain planted for a hundred years but also exclude other claims to their use or ownership. Such rules are called 'permanence instruments'. They operate by imposing definitions on heterogeneous elements. The Kyoto Protocol definition of 'eligible forests'[33] was one such definition.

This link to the Kyoto protocol anticipated the global trade of carbon credits under the Kyoto regime and was also part of the push towards the marketization of emissions. These rules were not just written and agreed between parties, but required a range of socio-material actors – photographs, measurement and computational equipment – to quantify and verify forests and their owners.

As MacKenzie maintains (2009b; 2008), acts of accounting and classification are choices. In the case of the biosequestration rules, classifying an afforestation project as compliant presumes that a number of questions have been answered, such as: Can I provide evidence of the absence of trees on the site prior to 31 December 1989? If I can, what kind of evidence is valid? If I can locate photographic evidence, what marks denote the *lack* of forest? Can native vegetation and planted stands be distinguished in the photos?

NSW Forests marketed their offsets by presenting annotated aerial photographs at carbon offset conferences, making these implicit choices seem natural. As no criteria for distinguishing land that contained 'non-forest' is defined in the Kyoto text, NSW Forests used a baseline figure of 80 per cent land area free of forest cover (O'Brien, 2005). This (self-imposed) requirement was met by calculating 'net stocked area' by cross-referencing three separate sources: visual assessments of satellite imagery and aerial photographs where available; forest record keeping; and a land titles search (Welch et al., 2007). Inventory records and contractors' invoices were also used to confirm date of planting. Patches of existing forest were identified and deducted from the eligible area (Welch et al., 2007).

The risks to these newly established 'biosequestration' forests were countered with three 'permanence instruments', which allow the management of forestry carbon sequestrations to be monitored over time and space with numerical precision. These instruments were important performative aspects of the NSW GGAS in the sense that they enact techniques of monitoring and accounting with their roots in *Forstwissenschaft*. These techniques in turn produce and rely upon the persistence of title over the trees and their continued growth within statistically manipulable parameters. In governmentality and material

sociology terms, permanence instruments were performative of both expert authority and its distance from political programmes through the creation of devices to quantify carbon over time.

The first 'permanence instrument' was that NGACs were registered for a 'carbon pool' of forests rather than being attributed to individual properties. This 'instrument' allows for harvesting and replanting of individual stands, or coordinated harvesting in cycles. The second 'permanence instrument' is a rule that requires abatement certificate providers to maintain carbon stocks within the carbon pool equivalent to the cumulative registration of certificates for a period of 100 years. This rule means that only the minimum 'stock of carbon' over the course of the scheme generates certificates, creating the incentive to have the greatest possible diversity in age classes of the trees in the pool. This diversity means that a small pool with trees planted across a large spread of years would generate more credits than a large pool[34] requiring simultaneous harvesting.[35] The creation of a pool also means that forests within that pool could burn down and be replaced with 'new stands'. If fire destroyed part of the pool, the regrowth stocks would hold more carbon according to these growth models, thereby generating more NGACs.

The third 'permanence instrument' imposes a requirement that certificates be ostensibly registered *ex-post* (after sequestration has occurred) for years in which there is net sequestration. Both forestry managers (Welch et al., 2007) and civil-society experts (Passey et al., 2007) have suggested that an effective carbon price would alleviate pressure on native forests being logged for timber production. However, the *ex-post* registration requirement and the 100-year rule raised concerns about the compatibility between GGAS and subsequent international trading schemes. The coordination and compatibility problem lies in the fact that NGACs are a credit generated by the *absence* of power-station emissions in NSW. Quantifying an *absence* of emissions relies on agreed rules and the authority of those interpreting those rules, rather than an agreed body of knowledge that can be independently verified and witnessed as embodied in a cap.

The 'technopolitics' of the NSW carbon offsets has seen a number of concerns raised by civil actors, concerns which have been responded to through rules, models and assurances. For example, Passey questioned the 'ability to enforce maintenance of plantings for 100 years … particularly when there are likely to be marked changes in temperature and rainfall over that time that impact the viability and carbon balance of such ecosystems' (Passey et al., 2007: 14). Forestry managers responded

to such concerns with increasingly complex modelling techniques, promising 'a new suite of carbon growth models that were well documented and include all relevant input variables, each with its own statistical distribution so that uncertainty analysis could be conducted' (Welch et al., 2007: 2). These models assume that 'areas are replanted; that subsequent rotations have the same species mix; and that there is no change in productivity between rotations' (Welch et al., 2007: 2). The models draw from both international silvicultural literature and NSW Forests' own research plots from which yield tables were developed.[36] These yield tables are both techno-political and economic 'black boxes' for market participants in the sense that Forests NSW's claims to land remain uncontested. Furthermore, concerns about the validity of modelling, such as those raised by Passey, did not affect the market price for forestry NGACs. In other words, the authority of silviculture experts was sufficiently aligned with the instruments and devices to assert control over forests so that trade in NGACs was able to proceed.

The arduous requirement to account for rules enshrined in the Kyoto Protocol through complex permanence instruments would mean that Forests NSW would be the only one of four qualified parties to create NGACs. By the end of 2007, it had created some 1.3 million certificates, from 25,000 hectares of hardwood and softwood plantations (IPART, 2008), and it remains the only party to actually earn any NGACs through sales to electricity retailers. This outcome supports the argument that the freedom of economic choice valorized by neo-liberalism has required elaborate rules to construct the markets that supposedly operate with greater efficiency than do expert regulations. This is necessary not only to promote or entice trade, but to fundamentally guarantee the functioning of those markets. Over the century-long time horizons written into the Kyoto Protocol, the sheer volume and complexity of rules and regulations for carbon offsets has proved too great for non-state offset providers who lack the property, the skills and the deep relationships with government to participate in the creation of offset credits.

Making up energy efficiency

If the relative public obscurity of the forestry offsets lies in their performative co-constitution with early modern state practices, the colourful nature of the Demand Side Rules lies with more recent energy crises, stagflation and monetarist revolution. The first mass campaigns to save energy that emerged in response to the energy crisis of 1973–1974, demonstrated the vulnerability of the post-war economic system to energy supply disruptions.[37] In this context, as Foucault claims,

liberalizing the oil market 'appeared as the only solution[, by] rectifying erroneous investment choices made in the previous period because of interventionist objectives and techniques[;] ... liberalism was the only means of correcting these investment errors by taking into account a new factor of the high price of energy' (Foucault, 2008: 196).

However, experience with the demand-side rule points to the difficulties of transforming energy-use practices into the plausible, durable, passive commodities required for market liquidity. One area of difficulty lies in the heterogeneous ways changes to end use impact upon energy demand (Passey et al., 2007). For example, technological improvements in the design of appliances, including refrigerators and washing machines, might mean that they require less energy to run, or can be programmed to run at different times. The administrative challenge for bureaucrats, then, was to rule on appropriate baselines from which credit for 'abatement' (incorporating the factual and counterfactual) might be calculated for these numerous and diverse factors (Passey et al., 2007).

Material sociology insights into markets are particularly relevant here. For Callon, markets are not only a category of social relations characterized through a particular form of exchange but a function of the devices, competencies, rules and inscriptions that give prices their stability. From this perspective, firstly, engineering decisions about the energy efficiency of an appliance and the likelihood of its correct installation need to be made. Secondly, nomination forms need to be developed that legally transfer the rights of the accrued savings from the installed devices to the companies selling or, in the case of light bulbs, giving them away. Thirdly, audits involving phone polls need to be conducted to assess the accuracy of the installation rates assumed by the credits. Each of these processes, procedures and materials quantified emissions and allowed NGACs to be sold in the NSW market. The processes, procedures and materials are analysed in detail below.

No other jurisdiction had implemented a Demand Side Abatement scheme for greenhouse gases analogous to the methods proposed for NSW.[38] Broadly, the strategy was to award credits based on the number of installations of an efficient device, like a shower head or light bulb, multiply that by a 'default emissions abatement factor' (or DEAF: a figure representing the average energy savings realized if the device was installed) and multiply that further by an 'installation discount factor' (IDF) (a figure representing the likelihood that only some devices would be installed and function correctly for their lifetime).

This method assumed that the replacement of an electric hot water system by a gas one (DEAF = 20) was equivalent to installing five AAA

showerheads connected to an electric system (DEAF = 4) or less if the hot water system had an 'unknown' energy source (DEAF = 3.1) (cf. Crossley, 2008) meaning companies could have electricity demand-reducing projects 'deemed'[39] by the scheme administrator. This deeming in the case of giving away lightbulbs to householders meant that the savings were assumed to have occurred at the time of installation, with credit being given at that time rather than being measured *ex-post* to account for the local, material and aesthetic contingencies of household lighting arrangements. Many households rejected the light bulbs because of the colour, the temperature or because the bulbs simply would not fit.

Such contingencies were well-known to market participants; thus, for the credits created from the DSA rules to attain the status of a fact, several criteria needed to be met. IPART stressed that products must remain installed for their lifetimes (e.g., Boardman, 2006). Depending on how the product was installed, an Installation Discount Factor was then applied. For example, for the 2003, 2004, and 2005 compliance periods, a compact fluorescent lightbulb (CFL) given away for free had an IDF of 0.8 – effectively assuming a 1 in 5 chance that it would *not* be installed. Thus a CFL would create 0.4 NGACs. This architecture brought new 'social entrepreneurs' (see below) on board to distribute small energy-efficient appliances en masse. However, in discussions (IPART, 2007) around the design of Demand Side Abatement provisions, no empirically grounded reference point determined the figure, effectively transforming the rule into an *in vivo* experiment to test the proposition that IDF was 'a predictor of human behaviour [regarding the use of the various appliances]', as one of the bureaucrats involved described it (Boardman, 2006).

The market price for permits reflected the release of data about installation. With a spot NGAC price of around $12 in 2005, the generous assumption of immediate installation created a lucrative market in supplying energy-efficient light bulbs and showerheads to householders. To tap into this market, however, companies would first have to apply for accreditation into the scheme, a process consisting of several phases (IPART, 2007). In phase 1, the project proponent submitted an application form with information about the project (for example, giving out light bulbs) for which they were seeking accreditation, paying a non-refundable $500 fee. In phase 2, the scheme administrator determined whether the project fulfilled the relevant criteria, ensuring its additionality (the extent to which its occurrence could be attributed to the scheme, rather than some other incentives or policies). 'Additionality' requires a staging and performance of the

proposed incentives from existing arrangements. If the project proponents could demonstrate that a pre-accreditation audit of the application could take place (IPART, 2007).

Performing audit: reconciling compact fluorescent light bulbs

The number of NGACs created on the IPART registry embodies a long chain of trust relationships between offset providers, their auditors and state regulators. For this number to achieve the status of facts about emissions *reductions*, however, these relationships needed devices to verify that certificate creation corresponded to the correct installation of bulbs. Such facts matter to markets in the sense that liquidity requires that the information relevant to market participants be visible. Thus, facts (such as the number of credits produced by Easy Being Green) must be 'detached from their circumstances of production' (MacKenzie, 2009b) through devices to verify that installation took place and thereby secure the trust relationship necessary for the market to function. Liquidity is 'a matter of the sociology of knowledge' (MacKenzie, 2009b: 10) insofar as certificate purchasers are reflexively aware of the circumstances of certificate production, rule setting and verification.

However, the experimental nature of the scheme (rather than its grounding in a mutually agreed cap as with the US sulphur scheme) saw it proceed in two main stages: a mania of give-aways leading to market saturation, followed by concerted attempts by some of the accredited firms to apply adjustments to rules in order to allow them to maintain their business (Warren, 2007; Bishton, 2009). Easy Being Green, the company listed above, created 3.8 million or around 21 per cent of the residential energy efficiency NGACs between 2003 and 2007 (IPART, 2008). However, this meteoric rise brought with it an equally precipitous fall: On a chilly Sydney morning in September 2007, the workers of the firm Easy Being Green assembled at Erskineville Oval in the shape of 'CO_2'. The company's Director,[40] Paul Gilding, former Greenpeace Australia executive director and self-described 'social entrepreneur', publicly described the stunt as a final bid to save Easy Being Green, whilst negotiating with the federal government on transitional assistance.

The development of Gilding's business model demonstrates economic sociologist Harrison White's observation that competitive markets tend to emerge by observing and estimating the sales schedules of competitors (White, 1981). Gilding noticed that rival company Neco Environmental Consultants were making a modest income by selling discounted low-energy light bulbs at local markets and claiming the certificates, then worth about $12 each (Warren, 2007). Gilding worked out that he could

make a lot more money if he could give away large volumes of light bulbs and shower heads, provided the price of the certificates held and the rules of the scheme did not change. 'For months, shopping centres and malls across NSW were inundated by free-light-bulb stalls set up by Easy Being Green and then competitors, including Origin Energy and AGL, who soon twigged to the free lunch on offer.... Spruikers of free bulbs would say "100 per cent free.... All you have to do is sign this form."' (Bishton, 2009). Bishton writes:

> The form was a nomination form, which stated that the hapless coal-fired electricity consumer could have the bulbs for free, if they promised to use them – as long as Easy Being Green could keep the saved energy. Or to put it more accurately, claim a certificate representing a tonne of saved carbon, which could be sold on ... the NSW Greenhouse Gas Abatement Scheme. (Bishton, 2009)

It is estimated Easy Being Green made more than $30 million in generating abatement credits this way (Warren, 2007). Income slowed in August 2006 when the independent regulator downgraded the value of the emissions reduction, but only after almost 16 million light bulbs and 1.2 million showerheads had been given away. The abatement of greenhouse had evolved into households stockpiling free light bulbs (Warren, 2007). The downgrading occurred when IPART noticed that the market for showerheads and CFLs was rapidly approaching saturation (Figure 3.6). By August, they had estimated that by December 2006, almost as many showerheads would have been distributed as there were eligible showers in NSW, and about two thirds of the CFL market would have been exhausted (see Fague, 2006).

In other words, the 'facticity' of the credits from the light bulb and showerhead giveaways, which was already putting downward pressure on certificate prices, became a public question. As a result, in an attempt to ascertain and expose installation rates of light bulbs and showerheads, Newspoll was commissioned to enquire into giveaway programs (Boardman, 2006). A sample of some 400 recipients of free bulbs in Sydney found that only 46 per cent of the respondents who had received a pack of free CFL bulbs had actually installed them (in 2006 a clause was added to Rule 3 that a household could only receive 6 bulbs) (Boardman, 2006). These results were weighted and a new installation rate was then calculated (Boardman, 2006).

Passey et al. (2007) estimate that by January 2007, over 6 million NGACs had been created through CFL and showerhead giveaways for

the 2006 compliance year, bringing the total to over 7.3 million NGACs. Although many of these (just under 2.2 million) were created after 1 October 2006, it is likely they were created from nomination forms signed before this date and so use an IDF of 0.8. Having acknowledged that the NGACs created through CFL/showerhead giveaways represent less greenhouse emissions reductions than originally thought, Passey et al. argued that IPART's calculations for per capita emissions in NSW for 2003, 2004 and 2005 would be inaccurate – unless the abatement value of these NGACs was reduced, which would mean confronting companies like Easy Being Green.

Passey et al. (2007) challenged the 'additionality' of the credits gained under the NGAC rule insofar as 'creation of NGACs is based on perceived abatement with respect to BAU rather than on physical emissions'. For Outhred, this reflects a deeper issue, namely that the certificates 'basically have inflation built into them – in other words they always will be less than the stated physical emission reduction, because the drivers are just one way to create certificates at minimum cost' (quoted in Bishton, 2009). This highlights the disjuncture between the levels of trust garnered by authorities in the US sulphur permit scheme through the construction of physical emissions' monitoring, and the levels generated by the abstraction of carbon offsets as counterfactuals in the NSW scheme.

IPART had offered a new kind of concession with their announcement that a compact fluorescent globe physically installed by a staff member could now be claimed for 100 per cent of its energy-saving potential. So began the transition to the convoluted model of home installations. However, confronted with a saturated market, the financial situation for companies surviving solely on NGACs, as 2007 wore on, became desperate. The price for a single tonne of carbon on the NSW market was plummeting and there were no plans to prop it up. In June 2007, the Howard government established an inquiry into emissions trading, halving the price of certificates as expectations of a national successor to GGAS gripped the market (Warren, 2007). Gilding pushed on with his direct-installation model. As one installer explains:

Teams would go to suburbs that had large houses and lots of lights that didn't necessarily get used.… There may have been only two people who lived in that huge house but if they had a lot of light bulbs that was the main thing. It would probably draw a similar amount to a small house in Penrith that only used eight light bulbs all the time, but an eight-bulb house was often not worth the effort because of the time it took. (Meagher quoted in Bishton, 2009)The initial daily sales targets of 195 bulbs installed per team were increased to 240 per day, and the pressure

on employees to hit these figures increased, putting further pressure on employees to give away bulbs rather than install them directly (Bishton, 2009). Moreover,

> [b]ulbs that didn't last, or were not used, for the full 15,000 hours intended meant less carbon was saved than was represented on a trading certificate. There were other factors that compromised the value of the bulbs as emissions reducers. Installing CFLs next to bathroom heat lamps or into sockets fitted with dimming switches could cause them to explode, but many were installed there regardless. The bulbs are also not meant to withstand extreme heat, but some teams had even been installing them in ovens. (Bishton, 2009)

Gilding met with the NSW government to negotiate an assistance package for the company until details of a federal scheme became clearer (Bishton, 2009). However, the NSW government blamed the federal Liberal government, which had said it would introduce its own carbon market but delayed its start until 2012 (Wilkinson, 2007). NSW Environment Minister Koperberg publicly claimed that 'Announcing that NSW's successful Greenhouse Gas Abatement Scheme would be scrapped if a national scheme is introduced, without providing any of the detail, was extremely irresponsible' (quoted in Wilkinson, 2007). However, the market had already given up the scheme. An oversupply of cheap, dubious credits and endemic uncertainty saw prices crash.

By the end of 2007, the energy retailer Jack Green had acquired Easy Being Green's key assets, including the database of hundreds of thousands of residential energy users who had signed up to receive free light bulbs. Easy Being Green's debts also led to the closure of Gilding's Ecos Corporation, an environmental consultancy for a number of large multinational corporations. Gilding claims on his website: 'Although with the collapse of the NSW state carbon price these businesses failed – although by traditional criteria they were great successes in social entrepreneurship, dramatically breaking new ground and showing the way for many other businesses to follow'.

Conclusion

The matters concerning whether the NSW GGAS would function correctly or not went well beyond normal questions that concern climate policy, such as whether a tax would have been more effective, or the level of emissions-reduction ambition that would be appropriate

(cf. MacKenzie, 2009a). Rather, a range of other 'sub-political' factors, devices, rules and mechanisms outside the purview of mainstream political discourse were pivotal as to whether the scheme would succeed or not. Indeed, many of these rules were not disclosed at all, most notably the classification criteria for Category B generation. This classification was highly consequential as the most credits of all methodologies were earned under the generation rules.

For Callon, the distance between discourses and the socio-material *agencements* is both the site of politics and the efforts of economists to devise new ways to calculate. Therefore, when multiple discourses are brought to bear on a socio-material *agencement*, matters of concern arise. Rather than arguing that carbon offsets are 'false commodities' or 'socially constructed', this chapter has instead shown how carbon offsets were produced to generate accountable numbers, using a range of technologies, models, estimates and, in the case of the energy-efficiency offset rules, simple guesses from first principles. Economists, in the broad sense understood by Callon, translated theory into practice and then into institutions. However, the outcome of this market-construction process was a labyrinthine arrangement of numbers with varying degrees of credibility. The guess-work, imprecise numbers and post-hoc audits involved in the development of energy-efficiency carbon offsets highlight the imperative to link various scales of experimentation in policy development.

However, the case study highlights two conceptual issues with Callon's 'civilizing markets thesis'. Firstly, Callon does not explicitly view calculability enough in historical terms. The practical ways that silvicultural experts made trees correspond both to their models and to the financial needs of state agencies is instructive here. As Lohmann has repeatedly suggested, silvicultural models are not wrong (Lohmann, 2010; 2009) but, rather, they link forms of thinking about trees (and the world around them) as manageable, with practices to achieve their calculability.

The GGAS embodied a paradox of neo-liberalism: its ideas of efficiency are premised upon the removal of public, central authority but necessarily require this authority to enact its radically decentred vision. The ambit claims of efficiency were based upon counterfactuals not embodied in some essential logics of the state that must be fought through a revival of community, as Lohmann argues. Rather, the particular logics of jurisdiction should be examined in the context of liberal governmentality connecting thought and practices to make calculability possible. Foucault's concern with the historical configuration of

problems, which led to the development of the modern state (*dispositif* in his terminology), highlights the way liberalism is not freedom from government or liberation from sovereign power, but is itself a political technology that operates through quantification and measurement in a shifting assemblage of techniques and devices. As this chapter has shown, neo-liberalism was not simply an ideology to remove 'government' but rather an *agencement* that redrew the boundaries of state and corporate, public and private, through the calculations of the market.

This chapter has documented the multitude of technologies necessary to produce public, factual numbers representing carbon offsets. However, it also has revealed problems with maintaining control over the reductions of emissions within a single jurisdiction. Far from replacing bureaucratic expert judgement with the transparency and objectivity of price, the 'paradox of measurable counterfactuals' expresses how judgements about how many credits could acceptably be generated were political decisions that ensured neo-liberal discourse could, by maintaining a cheap supply of credits, assert itself more powerfully in the electricity market *agencement* than alternative forms of regulation. As we shall see in Chapters 4 and 5, these political decisions, which undermine the case for the civilizing potential of markets, are also repeated at an international level.

Appendix A: NSW pool calculations

The NSW pool coefficient represents an average of the five previous years' annual pool values (APVs) lagged by two years. The APVs are estimated greenhouse emissions per MWh from the pool of major power stations in NSW (known as Category B generators) and from interstate flows from generators in other states of the Australian National Electricity Market (NEM). IPART estimates the emissions associated with electricity use in NSW by multiplying the NSW pool coefficient by the annual NSW electricity demand. The GGAS annual emissions targets are calculated by multiplying the NSW population with that year's per capita emissions benchmark. The annual NSW requirement for certificates is calculated by subtracting the annual emissions target from the estimated total NSW emissions (after allowing for transmission and distribution losses) (Passey, MacGill & Outhred 2008: 3007).

4
The Technopolitics of National Carbon Accounts

Technopolitics of classification is sorely lacking in much climate policy analysis. Policy details matter much more than the headline figures of emissions-reduction numbers imply. These numbers wrongly presume a common and agreed calculative 'frame', to use Michel Callon's term for the often-unstated infrastructure of economic exchanges. This chapter explains how land-use calculation relies upon decisions and judgements. For this reason, the rationalist dream of a decisively framed global 'nature' against which a global carbon price can be calibrated is inherently political. Furthermore, rationalists' reliance on a misguided concept of nature obscures expert judgements and the very practice of making the world accountable. In exploring the decisions required to make land-use change accountable, this chapter shows how the politics of the Kyoto Protocol are not reducible to pre-existing social interests on one side and natural representations (especially of trees) on the other, as assumed by many liberal commentators; but, rather, this politics involves social-group formation around issues.

National carbon account numbers under the Kyoto Protocol are part of a cumbersome apparatus of calculation and control, ostensibly underpinning international negotiations of greenhouse-gas mitigation measures under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. National carbon accounts are intended to represent scientific knowledge of industrial and land-based greenhouse-gas emissions and sequestrations within the territories of the nation states that are parties to the Protocol. They inform and document annual changes in greenhouse-gas inventories according to anthropogenic and natural changes, including those resulting from policy interventions by parties and associated governing bodies.

The most common image associated with the global negotiations is one of national industrial emissions per capita, where measures of industrial output and economic growth are compared to the population of signatory nation states. However, land-based and industrial emissions have very different calculative arrangements associated with them. The challenge for effective governance of the Protocol is that stated ambitions to reduce greenhouse-gas emissions are attributable to policies with that goal, rather than occurring through economic or natural processes outside the control of government. Indeed, the very possibility of accounting for changes to land-use, whether by policy measures defined in the Protocol or by natural processes, is not self-evident.

Accounting decisions based upon the representation of trees according to Kyoto Protocol definitions can have far-reaching consequences – such as whether policies will be deemed necessary to reduce industrial emissions within a jurisdiction in order to meet headline emissions-reduction goals. For example, if certain plant forms are classified as trees and their growth attributed to policies, nation states can claim that their emissions targets have been met by these policies. This is a significant economic question, with some $10–30bn in liabilities at stake in the case of Australia. In the world of international negotiations, trees are not so much a symbol of romantic natural mystique or conservative pride (as in the British Tory party logo of an oak) as, not than an invidious accounting concept.

Representing carbon fluxes

The expert discourse governing the UNFCCC is based on the translation of global knowledge of emissions into national and international policies. The idea that human interference with the carbon cycle can be objectively measured by national experts and verified by an international community of their peers ultimately underpins international negotiations to curb greenhouse-gas emissions.

As Brian Wynne has argued, what mutually constructs and reinforces one another are 'the intellectual order of climate scientific prediction, and the *political* order of global management and universal policy control based ... on the promise of deterministic processes, smooth changes, long-term prediction, and scientific control' (Wynne, 1996: 371). Calculations of 'carbon sink potential' from the 1970s onwards have been integral to the development of this order.[1] Scientists at this time sought to calculate how much carbon could be stored in forests, through tree growth and an increase in soil carbon. More recently, an Intergovernmental Panel

on Climate Change (IPCC) special report (Watson et al., 2000) stated that land-use changes[2] and forestry emissions account for 33 per cent of the approximately 405 Giga-tonnes (Gt) of human-induced carbon dioxide (CO_2) emissions from the period 1850–1998. However, this 33 per cent of carbon emissions (some 136 Gt) were presented to policy-makers within a wide band of estimation about their accuracy of some ± 55 Gt C. The width of this estimation has led some to question whether anthropogenic interference with the carbon cycle can be reliably translated into carbon commodities through the Kyoto Protocol mechanisms (Lohmann, 2005). Such disputes underscore the mutual relationship between trust in scientific certainty and economic calculation.

Calculations of carbon-sink potential align with mechanistic metaphors for engineering the carbon cycle, such as the 'planetary machinery' or 'the engine room of the Earth System' – as in Angela Merkel's adviser Hans Schellnhuber's (1999: 21) account. 'Green governmentality' metaphors of machines and engines reflect an image of nature which functions according to the order, certainty and predictability of physical laws (Lövbrand et al., 2008; Backstrand and Lövbrand, 2006). Accordingly, in this view, nature can be controlled by its human operator when fully described and predicted by science (Luke, 1999). The use of the concept of 'equilibrium' with regard to both markets and carbon stocks reinforces this discourse. For example, the IPCC Good Practice Guide provides methods of estimating emissions and removals of CO_2 and non-CO_2 greenhouse gases by assuming carbon stocks will adjust to a new equilibrium following a change in land use (Penman et al., 2003). Such assumptions presume the predictability of natural processes and facilitate their accounting and trading.

The problems of verifying how such wide-ranging assumptions could translate from models to data-gathering and facts signals that the UNFCCC negotiations have repeatedly failed to separate the techno-scientific study of carbon fluxes from the political negotiations of mitigation policy. For example, the Subsidiary Body for Scientific and Technological Advice (SBSTA) counsels the Conference of the Parties on matters of climate, the environment, technology and method. The official mandate of the technical body under the UNFCCC is to provide the Conference of Parties with 'timely information and advice on scientific and technological matters relating to the Convention'. However, as Clark Miller notes 'SBSTA deliberations are marked by a constant struggle to find generally accepted criteria and procedures for selecting experts and weighing evidence'. Considering the enormous political science literature on emissions targets and timetables, surprisingly little social

science work has empirically examined processes of 'boundary maintenance' in this setting (although, see Lövbrand, 2008). Perhaps most infamously, rich industrialized countries attempted to define forestry management such that they could claim credit for large increases in land-based carbon stocks during the negotiations of COP6 at the Hague in 2000. This would have meant they did not need any policies. This was rejected, and the Protocol was not ratified for another five years as Russia and other countries waited until it would be to their advantage (so called 'Hot Air'). This kind of boundary maintenance about legitimate and illegitimate measurement of carbon performs, that is both presumes and facilitates, models of natural processes in order to make possible accounting and trading.

Furthermore, discourses of control did not simply 'contribute' to the calculability of material inscriptions of carbon fluxes, as if discourse preceded action. Rather, these discourses developed together with practices of developing, testing and calibrating 'big' science projects informed by technology such as satellites. These projects provided the infrastructure that enabled environmental experts to monitor and, in many cases, even attempt managing of the earth's biogeochemical cycles, hydrological flows and human patterns of pollution and environmental degradation (Lövbrand and Stripple 2009). Crucially, satellite remote sensing has enabled new forms of monitoring and control of distant populations of land-users. The UNFCCC has relied upon an inherent confidence that 'systematic investigations into the truths of the natural world will foster a more rational human management of the environment' (Lövbrand and Stripple, 2009: 12).

However, reason has not overcome ignorance in the ways Schellnhuber and other scientists have hoped. Rather, new problematizations of supposed techno–political 'solutions' such as carbon offset methodologies to Reduced Emissions from Deforestation and Degradation (REDD) have challenged the status of expert advice as a politically neutral antidote to ignorance. Disputes over accounting definitions exemplify this dynamic of problematization. Over the course of the negotiations of the Kyoto Protocol and its successor, defining which human activities would be optional, in terms of accounting, and which would be mandatory, has been the subject of intense political negotiations. These negotiations have not only reflected the divergent interests of industrialized and developing countries in the *real politik* of industrial competition, but have also rendered visible competing discourses about the relationship between science and policy.

Defining and classifying carbon sinks: measurement, reporting and verification under the Kyoto Protocol

There are many productive parallels between financial and carbon accounting; for both depend on acts of classification. For a firm to measure and report its profits, for example, each transaction or economic item must be classified according to local and global rules and conventions (MacKenzie, 2007; Hatherly et al., 2008). Carbon accounting also requires work to classify what counts as a 'human activity' and, hence, what economic policies will be necessary for a party to meet its target. The Kyoto Protocol rests on calibrating each party's emission-reduction targets, referred to as 'assigned amounts' for industrialized countries. Taking 1990 as the base year, countries pledged to meet their reduction targets during the first commitment period 2008–2012.

The promise of developing a global carbon market was a key factor behind the United States' decision to sign the Kyoto Protocol (MacKenzie, 2009b). At the heart of the Protocol are national carbon accounts against which headline reduction targets are negotiated.[3] In order to govern the climate through the UNFCCC process, climate experts have been engaged in complex methodological processes to adjust measures of carbon fluxes to national territorial borders. These experts have developed and recommended classifications and processes to report national inventories of the sources and sinks of greenhouse gases in a uniform manner to the UNFCCC Secretariat in Bonn.[4]

The role of scientific expertise in this process of policy development was imagined to reflect earlier agreements that placed UN scientific institutions at the centre of negotiations.[5] The UNFCCC negotiations have sought to separate the techno-scientific study of carbon fluxes from the political negotiations of mitigation policy. This separation of method and technical advice from policy serves to frame territorial nation states as the managers of the global warming issue by demarcating the representation of carbon fluxes from the negotiation of economic issues. National inventories were thus developed to quantify and report industrial emissions and terrestrial greenhouse gas fluxes within geopolitical and territorial structures. These inventories represent a report of what was emitted and sequestered within respective state borders according to guidelines agreed by the parties, though it is the responsibility of each signatory state to report their emissions. These reports, it was then hoped, would allow the allocation of responsibility to be negotiated between such sovereign entities.

The legally binding Protocol[6] negotiated in Kyoto in 1997 added a further set of reporting requirements, placing definitions of the sources and sinks of the industrialized countries' emissions at the centre of political negotiations. However, the process of building facts about national emissions is not simply a techno-scientific process analogous to the monitoring of industrial emissions from power stations and industrial facilities. Rather, different parameters for reporting and accounting emissions under the UNFCCC and Kyoto Protocol systems provide different opportunities for national governments to 'game' what counts towards their targets in their own interests. For example, Australia assumes that bio-carbon fluxes classified under 'forestry management' equilibrate over time to being carbon neutral in its national accounts to the UNFCCC Secretariat (Commonwealth of Australia, 2008). This means that Australian policy measures are made against an assumed baseline in which the trees defined as 'managed' (by landholders and silvicultural experts) have an equivalent natural state to which they will return.[7] This assumption reflects the *Forstwissenschaftler* view of forests in the sense that nature is seen to be governed by predictable rules from which mathematically calculable objects can be separated, manipulated and managed. As one interviewee stated, this is 'a pretty big assumption' (Picker interview). The significance of this assumption is that it indicates practical limits to measurement. Just as firms cannot account for every cost, the techno-scientific framing of carbon accounts cannot measure every tree or each handful of soil.

MacKenzie's (2009b) analysis of development of emissions trading emphasizes the materiality of monitoring and verification systems. Without the Continuous Emissions Monitoring System, the US acid scheme would not have won support from key NGOs sceptical about supporting a market-like mechanism. Furthermore, MacKenzie stresses that the tractability of measurement issues is a key determinant governing which carbon offsets are produced through the CDM (as discussed in the next chapter). However, his guarded optimism for a carbon trading scheme only explicitly deals with industrial and energy emissions – just one part of the carbon accounting machinery.

Despite the importance of land-use accounting to 'framing' reductions in industrial emissions, the political nature and significance of land-use accounting remains underappreciated. The complex relationship between estimates and measurements in official accounting of land-use change emissions has been negotiated within an emergent community of international experts working within UNFCCC negotiations. At a practical level, the verification of national carbon accounts

has been established with a view to modernizing the state in developing countries. As one interviewee commented, systems of audit, reporting and peer review to ensure scrutiny and probity of carbon accounting is a 'cottage industry' compared with international financial systems. Accounting systems for land-based carbon fluxes in developing countries remain a low priority for modern governments attempting to modernize often ailing post-colonial infrastructure and govern ethnically diverse populations.

One important aspect of the small, communal development of expert peers has been the embedding of social ties between Land Use, Land Use Change and Forestry (LULUCF) negotiators. Several interviewees responded that, within national negotiating teams (which range from one or two representatives for the smallest countries to delegations of hundreds for large industrial countries) LULUCF negotiators are often seen as marginal to the central tasks of negotiating a political agreement. Their marginal status in the negotiations means that social bonds between LULUCF expert negotiators are often stronger than within national negotiation teams. A former negotiator recalled that it is customary for these experts to bring a bottle of wine from their home countries to each COP meeting – a reflection of communal bonds developed as they negotiate the political and technical complexities of accounting for land-use (LUC) change and forestry emissions.

However, LULUCF has moved from the periphery to the centre of negotiations at crucial points. As MacKenzie argues, 'the scales aren't stable' in accounting regimes – seemingly marginal details, such as the definition of a tree has impacted how carbon fluxes in the land sector should count towards a country's assigned amount of carbon emissions. Developing country parties would often challenge developed countries' attempts to claim credit for fluxes in biomass carbon within their territories. COP-6 at The Hague in 2000 exemplified this process as the United States argued that an increased rate of forestry growth meant that it would not need to make significant reductions in industrial emissions (Grubb and Yamin, 2000). Civil-society actors attempted to disclose the politics lurking in the technical definitions of forestry carbon uptake presented by the United States. They argued that a loose, 'pick-and-choose approach' to forest definitions would allow large forest nations in the northern hemisphere to claim credits for activities on land which could not ordinarily be described as a forest.[8]

The advantage of the concept of an economic *agencement* in this context is that it sidesteps the question preoccupying some critics as to whether it is 'really possible' to distinguish human from nonhuman

entities and processes (see, e.g., Lohmann, 2005). Instead, it allows the definitions, rights and measurement devices implicated in giving boundaries to economic transactions to be empirically examined to see how it is done. This has a bearing on issues such as whether or not a party would need to buy offsets through the flexible mechanisms to meet its target.

The IPCC-recommended response to the problem of measurement has been to frame a subset of definitions for which 'land managers' could be held accountable. Furthermore, Articles 3.3 and 3.4 of the Protocol mean that deforestation figures directly affect the number of Assigned Amount Units (AAUs) necessary for a country to hold relative to their emissions reduction target.

The Kyoto Rules assume 'anthropogenic' interference can be distinguished from natural carbon fluxes, then seek to translate these fluxes into accounting items for 'forestry management'. This allows signatory parties to claim that changes to some fluxes were caused by policy measures.

Under Article 3 of the Kyoto Protocol, parties must account for changes to forests, defined as:

- Reforestation – forest occurring on what was non-forest on 31 December 1989
- Deforestation – non-forest occurring on what was forest on 31 December 1989
- Forest management – forest occurring on what was forest on 31 December 1989

The best negotiators could agree upon for defining a forest was a range from which parties could select their own definition.

Minimum land area 0.05–1 ha

Minimum crown cover 10–30 per cent

Minimum height 2–5 m

Australia has chosen the following definition of a forest, which matches the definition used for UNFCCC, reporting:

- tree height of at least 2 metres;
- tree crown cover of 20 per cent or more; and,
- a minimum area of 0.2 hectares.

The Kyoto Protocol further stipulated that measurement requires 'Measurable, Reportable and Verifiable' data. These definitions of measurement and verification are troubled because it is an international expert body selected by the UNFCCC Secretariat that scrutinizes the reports.

Finally, the Kyoto 1990 baseline with annual accounting towards a 2008–2012 commitment period created a time frame for accounting for changes.

This bias towards trees enshrined in the Protocol[9] excludes shrubs, wetlands and sparser forms of vegetation, none of which may be taken into account. A key reason for this focus on trees is the precision with which remote-sensing technology can monitor changes in deforestation compared with other forms of land degradation (Rosenqvist et al., 2003). New (post-1990) activity in establishing forests (afforestation and re-forestation) is credited, and land clearing ('de-forestation') is penalized under Article 3.3, which states that, 'the greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner.'[10]

One important consequence of this accounting approach to carbon sinks classification is that some emissions are excluded from reporting for the sake of uniformity and clarity (Watson et al., 2000). For example, the clearing of vegetation that is not a 'Kyoto forest', under the Kyoto definition, and the logging of Kyoto forests that remain Kyoto forests after harvesting is reported by industrialized parties. However, both these actions create greenhouse-gas emissions that contribute to global warming.[11] Some have therefore warned that 'solving problems through centralized controls and global blue prints tends to create its own vulnerabilities in the long term' (Boyd, 2009: 3). Thus, the 'facts' and figures that are used in carbon accounting are not 'given from nature', but are derived from a politics that pits communities of experts, techno-scientific methods of classification and measurement, and local, international and global interests against one another.

The political economy of carbon accounting: Article 3.7 as the 'Australia Clause' controversy

The choice of how carbon sinks are accounted for and the methods by which they are counted has a direct bearing on a party's emissions-reduction commitment and, consequently, on their economic competitiveness. Interpreting rules governing what count as 'human activities' and how to measure them is thus a deeply political matter although it is seldom recognized as such in mainstream discussions of

negotiating targets. Eva Lövbrand (2008) has examined in detail the politicization and scientization of experts' carbon-accounting processes since the ratification of the Kyoto Protocol. The official mandate of the technical body under the UNFCCC is to provide the Conference of Parties with 'timely information and advice on scientific and technological matters relating to the Convention' (UNFCCC, 1992a). However, Miller notes (quoted in Lövbrand, 2008), 'SBSTA deliberations are marked by a constant struggle to find generally accepted criteria and procedures for selecting experts and weighing evidence'.

Article 3.7, a late inclusion in the negotiations, was proposed by the Australian delegation on 11 December 1997 as negotiations continued a day longer than scheduled (Hamilton, 2007). It specifies that industrialized countries may claim reductions in greenhouse emissions from land clearing towards their reduction targets. Because Australia was the only party with declining land-clearing emissions since 1990, Article 3.7 was dubbed by environmental campaigners as the 'Australia Clause' (Hamilton and Vellen, 1999; Hamilton, 2007).

Hamilton and Vellen (1999) estimate that the inclusion of Article 3.7 gave the Australian government a 19 per cent reprieve in its emissions target, saving the country at least $10bn over the course of the Protocol's commitment period. These estimates are derived from Australia's Kyoto Protocol carbon accounts,[12] which specify that parties to the Protocol must submit an inventory of greenhouse emissions. This inventory provides the basis of pledges to increase or reduce emissions. The 'assigned amount' is allocated according to these inventories. For example, as a signatory to the Kyoto Protocol,[13] Australia pledged to *increase* net emissions by 8 per cent from the 547,699,841 tonnes of CO_2 equivalent emitted during the 1990 base year (UNFCCC, 2009). This crucial figure was disclosed in the initial report to the UN Secretariat submitted in 2008 in response to Australian ratification of the Protocol. Australia maintains that its inventories for land-use change have been consistently reported since the Kyoto Protocol was negotiated.[14]

The point here is not to assess the specific attributions of agency and responsibility underpinning the claims of successive governments to have reduced greenhouse emissions.[15] Rather, it is twofold: firstly, to show how carbon-accounting rules are constrained by the material limits of demonstrable evidence of anthropogenic deforestation. This includes the rule-making process embodied in UNFCCC negotiations. Secondly, the 'Australia Clause' provides a useful point of reference for critically assessing the epistemological basis of liberal institution-making in representations of nature – in this case, trees.

Making a national carbon sink – technologies of carbon accounting

The international debate about whether or not Australia's carbon accounts are factually robust and consistent assumes that monitoring technologies provide more or less transparent access to their objects of measurement. But this is an assumption that confines the debate to realist or rationalist discourses. What is at issue is the term 'Australia'. The advantage of the concept of *agencements* is that it suggests that, in the UNFCCC negotiations, actors like 'Australia' are produced and configured in specific legal, cultural and technical settings. The previous chapter argued that the normalization of timber performed by silvicultural experts through concepts such as *normalbaum* was crucial to the formation of cameral government. State financial and biomass accounting were literally produced alongside one another. The material production of carbon accounts is thus part of the performance of state legitimacy and assertion of national sovereignty in international negotiations recognized in realist discourse.

Practices of classification 1: trees in the field

Firstly, the legitimacy of the deforestation figure provided in the UNFCCC report ostensibly reflects its calculation through the expert appointments of a democratically elected government. Chapter 2 of the IPCC Good Practice Guidance for LULUCF (Penman et al., 2003) outlines three different approaches to representing the land-area classifications to be reported under the UNFCCC: basic land-use data, surveys of land-use change, and geographically explicit techniques. The first approach 'uses area datasets likely to have been prepared for other purposes such as forestry or agricultural statistics' (Penman et al., 2003: 2.6). The second approach 'provides a national or regional-scale assessment of not only the losses or gains in the area of specific land categories but what these changes represent' (i.e., changes from and to a category such as forests to grassland) (Penman et al., 2003: 2.7). The third approach requires 'spatially explicit observations of land-use and land-use change. The data may be obtained by sampling of geographically located points, by a complete tally (wall-to-wall mapping), or by a combination of the two' (Penman et al., 2003: 2.11).

Australia's carbon accounts are the result of an extraordinarily complex combination of the second and third approaches – remotely sensed datasets that have been calibrated using surveys. The relationship between these two is analysed in turn. The figures these approaches

yield were developed from some 8 years of expert analysis and measurement, culminating in over 45 volumes of National Carbon Accounting methodology, technical analysis and policy/historical background work. This work can be traced back to 20 November 1997, the eve of the negotiations of the Kyoto Protocol, when Prime Minister John Howard announced that a new body, the Australian Greenhouse Office, would be established. A key task of the office was to develop 'a consolidated package [to] provide the comprehensive framework and scientific services necessary to account for Australia's emissions reduction and sink enhancement programs (in land based sources and sinks) to an internationally credible standard' (AGO, 1999b: 1). The primary policy requirement of this consolidated package, which would become known as the National Carbon Accounting System (NCAS), was to lend support to international reporting requirements under the UNFCCC. However, the bureaucrats appointed through a democratically elected government were only one set of experts to determine the inputs into National Carbon Accounts.

How 'geographically explicit' techniques are 'ground-truthed' – physically visiting a site to cross-reference land characteristics with satellite measures – and mixed with new survey data are a matter of national expert decisions. The LULUCF Good Practice Guide states that 'approaches are not presented as hierarchical tiers; they are not mutually exclusive, and the mix of approaches selected by an inventory agency should reflect calculation needs and national circumstance' (Penman et al., 2003: 2.7). This underscores the power vested in expert authorities according to prevalent understandings of national needs.

NCAS collated data from a range of disciplines and methods to allow policymakers to make authoritative decisions about the presentation of land-use figures for an international audience. Science Studies scholars have examined how various forms of expert knowledge-making have in recent years responded to demands to be more accountable to society (Gibbons et al., 1994; Irwin, 2006). One way of responding to these demands has been to create tighter relationships between commercial interests and academic research (Lave et al., 2010). Corresponding to this trajectory, much of the research for the NCAS is derived from industry-sponsored projects. The corporate influence on carbon measurement and accounting research served to entangle industrial interests with climate policy in complex and obscure ways.

For example, botanical research included in the NCAS is deeply embedded in the industrial interests of mining corporations. The companies hold pastoral leases 'not only for grazing purposes, but also

for strategic access for exploration, infrastructure development, future mining and production'.[16] In 2001, one of these mining companies sponsored a research project that saw botanists Mark Adams, Pauline Grierson and Andrew Bussau investigate the potential value of such land as a carbon sink. Hammersley Iron (now part of Rio Tinto) was an Australian Research Council Linkage Project partner with the University of Western Australia in conducting studies of the physiological properties of plants and grasses after grazing, fire and under different water-availability conditions. The company also sponsored a side project to estimate the carbon stored in the thousands of hectares the companies manage.

The group's work fed into the National Carbon Accounting System, insofar as it investigated 'sink enhancement programs [in land-based sources and sinks] to an internationally credible standard' (AGO, 1999b: 1). Between 1999 and 2006, some 49 technical reports were produced for the NCAS, mostly in aid of establishing the 'Full Carbon Accounting Model'. The botanists' major report (Adams et al., 2001) was delivered to Hammersley Iron and the other companies but it also provided methods for estimating the biomass of woody vegetation. These became an appendix to NCAS Technical Report 31 – Protocols for Sampling Tree and Stand Biomass (see Snowdon et al., 2001: 43–48).

In accordance with Australia's definition of forest, the mining companies were interested in the amount of carbon stored in trees that would meet that definition, as well as how much was stored in the woody shrubs common to the Pilbara. The companies investigated whether the definitions and thresholds designated by the government for a national scheme (such as whether a 1990 or 2000 baseline) would allow them to create forestry credits to sell into a national carbon-trading market if 'managed forest' coverage on their property had increased. Other proposals to extract value from the carbon stored in the biomass were canvassed, including sales of rights to root biomass (Sandor et al., 2002). However, the ostensible reason for the project was to 'provide information for the National Carbon Accounting System to the Australian Greenhouse Office as part of its reporting requirements for the Kyoto protocol' (anon, 2001: 11).

Sampling techniques for estimating biomass remain a 'black box' in policy discussions over carbon accounting. To arrive at figures for the carbon stored in the Pilbara grasslands, Adams and his colleagues needed to deliberate over in which areas to measure samples and how to actually sample the trees. They examined two eucalypts, River Red Gum *(Eucalyptus camaldulensis)* and Coolabah *(Eucalyptus victrix)*, which

are 'widespread throughout arid and semi-arid Australia and dominate creek and stream-lines – and ecosystem biomass' (Snowdon et al., 2001: 47). The twisted, irregular forms of eucalypts made sampling choices difficult compared with the uniform stands of silviculture plantations. Typical silvicultural practices involve measuring stem diameter at 'breast height' and calculating volume. Strong correlation between the volume of the plant, its stem measurement and the weight of the tree in plantations means only a small number of samples need to be taken to provide a reliable estimate of carbon in an entire plantation. Many studies have shown above-ground biomass of individual trees is linearly related to 'diameter at breast height' raised to a power in the range 2.0 to 2.5 (Snowdon et al., 2001: 57). Adams recounts their attempts to apply standard modelling techniques as follows:

> [T]he stem of every eucalypt sampled approximated a tapered cone for a few metres above ground level, at most. Beyond this height, stems were either non-existent or multiple or greatly deformed. Each tree contained either a main stem or one or more main branches that were either substantially hollow or at least partially decayed. The main branches of each tree (that together comprised a greater proportion of total mass than the stem) were highly convoluted in form and each tree had previously lost large secondary (or even primary) branches. Experience suggests that hollow or rotting stems and branches present an almost impossible problem to overcome. (Snowdon et al., 2001: 49)

The group decided to 'destructively sample' about two dozen specimens, recording their steps to give more accurate estimates of the carbon stored in the twisted boughs lining the creeks and rivers of the red centre of Australia: 'Record height, crown dimensions, basal diameter at 0.1 m and 1.3 m, diameter at crown break (or stem split), height at crown break/stem split of every individual stem, if tree is leaning over and angle to ground surface' (AGO, 2002b: 22). They noted the critical importance of measuring the diameter at each 'branching node', irrespective of the presence of dead or live sub-branches. Diameter should be measured immediately below and above each 'node', especially where one of the sub-branches is dead or has been abscised.

One of the NCAS technical reports notes that the issue of hollow, rotting stems alone mean that it is 'quite clear, from studies in both Australia and overseas that for each species and for each form of each species, a separate analysis is required [to avoid erroneous measurements]' (AGO,

2002a: 45). These sampling decisions and the data derived from them remain unchallenged, although it is conceivable that civil society actors could question this research area.

There is nothing inherently political about the measurement of biomass, although it has the capacity to become so. As a finitist analysis emphasizes, carbon accounting rules are not simply applications of natural concepts, but are developed over time as the heterogeneity of biomass is constrained by material limits (broadly defined). Industrial research funding, carbon accounting methodologies, measurement devices and sampling choices for anthropogenic carbon sinks are part of a complicated industrial-emissions trading *agencement*. These carbon-accounting rules are political in the sense that doctrines of national competition to measure economic efficiency extend even to the writing of rules. This gives the lie to the assumption that rules are given from 'nature' as realist accounts of climate policy assume.

Practices of classification 2: interpreting satellite data

The reliance upon expert interpretation to calibrate geographically explicit datasets with land-use change surveys has entangled carbon accounts with many other policy interests and bodies of expertise. The most prominent challenge to the government's deforestation rate, however, has utilized images constructed to quell social conflicts around land clearing, a form of deforestation highly consequential to the timescales of Kyoto Protocol accounting. Theorists of photography have long criticized the idea that images in themselves constitute evidence, questioning the opinion that an image is simply viewed by an isolated observer (Barthes, 1981; Sontag, 1977). The close relationship between photographic images and forensic science has historically served to enact expert privileges in the interpretation of photographic images (Edmond, 2000).

The previous chapter showed how aerial photography served the interests of state silviculture by representing forests as a singular object that was managed and traded through the NSW Greenhouse Gas Abatement Scheme. Concurrently, modellers at the Australian Greenhouse Office sought to find sufficiently high-resolution satellite measurements to estimate land-use change in order to create 'credible' and 'verifiable' accounts for a/de/reforestation for the whole of Australia during the decade from 1990–2000 within a budget of several million dollars. In a series of technical reports arising from a 1998 expert carbon-accounting workshop, aerial photographic records were immediately disqualified as being too expensive. In addition 'ground truthing' was impossible given

the requirement to establish trends from decades earlier. The remaining possibility was for government officials to use satellite remote-sensing images to measure changes in Australian land clearing over this period.

The credibility of Australian compliance with the Kyoto Protocol target would thus hinge on whether the definition of forest – chosen as a minimum of 20 per cent tree crown cover at a minimum height of 2m at maturity (AGO, 2002b: 26–27) – could be reflected in the coarse resolution satellite images analysed by technical experts. The National Carbon Accounting System description of the land-use change program, aimed to '(1) provide a 30-year monitoring of continental land cover change which commenced in the early 1970s; and (2) to provide a multi-temporal, fine resolution data series identifying through time, any land unit, land cover change (removal of forest cover and forest regrowth) attributable to direct human actions' (AGO, 2002b: 19).

Just as the complexities of visual evidence in judicial settings require a more sophisticated account of the relationship between expertise and photographic representation (Edmond, 2000), so the technical decisions in interpreting remote sensing data also require special attention. There are two crucial aspects of the interpretation of satellite data involved in creating Australia's Kyoto accounts: the threshold between forest and non-forest, and the attribution of the difference between the two categories to humans or natural causes.

However, before such judgements can be made, there are four processes involved in creating the data for the 1990 baseline, subsequent series and models of growth (AGO, 2002b). Firstly, satellite images are purchased (185 km by 185 km at 25m resolution by Landsat satellite images that have recorded data since 1972). Secondly, because different satellite images were required to cover the time series from the 1990 baseline onwards, they are cross-checked geographically, thereby dividing Australia (see AGO, 2002b). Thirdly, these images are calibrated using a reference image (Landsat ETM+ national mosaic for the year 2000) to 'adjust spectral characteristics to remove inconsistencies such as illumination caused by sun angle at the time of image capture' (AGO, 2002b: 22). Fourthly, the 185 km^2 images must be integrated into a single map of Australia by aligning the images and removing overlaps, a process that involves selecting 'features, such as corners of remnant vegetation, that have high contrast and distinct shapes' (AGO, 2002b: 116) as points of reference.

Before the deforestation figure is arrived at, at least two qualifications must be made to the raw data. Firstly, land-use change events are removed that do not satisfy the UNFCCC and Kyoto rules. A collection

of different masks[17] are applied, relating to such events as fire, land tenure, forest harvesting on private land, dryland salinity, drought and growth flushes (AGO, 2002b). Secondly, forestry operations (silvicultural harvesting and plantings) are not defined as land-use change under the Kyoto rules unless the land is converted from forest to non-forest condition and there is a subsequent change in the land-use: for example, managed forest to pasture (Macintosh, 2007a). For forest conversions, the vegetation change must be 'deliberately done for the purpose of the change in land-use'. That is, unless the land-use is changed to something other than forestry (as defined above), it is excluded from official accounts. These exclusions are a matter of powerful expert judgements, rather than simply being given from nature.

This ongoing role for expert judgements illuminates the value a finitist analysis for drawing attention to the ways in which meaning is negotiated on a case-by-case basis. Who holds records about previous instances of deforestation also has considerable power in negotiations because classification of interference with trees as human or natural is always a choice.

For these reasons, civilizing markets depends upon revisions of distinctions between the economic, political and techno-scientific dimension of carbon markets. Classification of interference with trees as human or natural is always a choice. The concern of attending to such decision-making also animates Callon's call to maintain *temporary* distinctions between the economic, political and techno-scientific dimension of carbon markets – measures of carbon fluxes (Callon, 2009). For, Callon argues, we should not succumb to false distinctions between real and constructed, but rather understand how framing is always an outcome of trials of strength whereby assumptions are validated and procedures revised. The politics of testing that arose from carbon accounting underscores the insight that measurement alone does not create facts from observation alone. These facts must be staged for an appropriate audience (Haraway, 1997; Shapin et al., 1985)

The accurate reporting and verification of carbon sinks is not simply a matter of deploying better technologies to represent trees at a higher resolution. Etymologically, the concept of 'transparency' implies that technologies are merely neutral mediums transmitting an external reality. The official Australian Greenhouse Office technical paper on establishing the 1990 baseline envisaged an ongoing process of incorporating new data into the baseline figure:

> The use of independent data (and where appropriate methods) for verification should be built into the program and archived as a part

> of decision tracking and support. Independent verification may also include use of third party assessment (AGO, 1999a: 4).

However, the civil expert challenge to Australia's official interpretation of its deforestation baseline suggests that more than simply 'better data' is at stake in the construction of a baseline. What is at stake is the model of nature upon which rationalist and realist discourses rely.

Within the architecture of the UNFCCC as well as within the Australian national polity, the factual status of the forestry baseline remains disputed. Australia's baseline figure was subject to a peer review process within the NCAS expert community. The Greenhouse Office technical report urged that 'the issue of transparency should be extended beyond openness to technical review and should be presented in a fashion which makes an understanding of the NCAS accessible to the public' (AGO, 1999a: 5).

The report found the thresholds which produced the high rate of land clearing in 1990 and were favourable to Australia's Kyoto target, were accurate at the time (Anonymous interview). An additional review was conducted by an expert review panel appointed to examine each party's reports under Article 8 of the Kyoto Protocol. The UNFCCC expert review of Australia's initial report found it to be 'generally transparent'. However, the authors remarked that 'during the review process the [team] identified emissions/removals from the LULUCF sector as a key area where transparency needs to be further enhanced' (UNFCCC, 2009: 4).

Environmental campaigns against biodiversity losses from agriculture provided de facto data on land clearing that has been used to contest official government measures relying upon remote sensing alone. This data, part of a coordinated social movement during the 1990s and 2000s, provide an opportunity to rethink the way carbon accounting operates as a technology of government.

Limits of remote sensing

The epistemological limits of remote sensing are widely understood. 'Time-efficient' satellite-based methods of surveillance have been used in a variety of land-use monitoring, regulatory and forensic applications in Australia and overseas for some time (Lambright, 1994). Satellite surveys at a resolution of ~30m have taken place across Australia since 1972, allowing states to monitor land-use changes without personal visitation or aerial surveillance. Forensic applications soon followed.[18]

Free online tutorials, such as the NASA Goddard Institute's 'Technical and Historical Perspectives on Remote Sensing' (Short, 2005) document how coarse resolution images are derived from various spectral frequencies measured remotely and translated into an image. Light spectrum is reflected at different rates according to foliage type (Short, 2005). The coarse resolution Landsat Multi-Spectral Scanner data received from these measurements of reflected light have a range of regulatory application, according to different spectral outputs. The mapping of remotely sensed data of the equivalent resolution explained in the NASA tutorials was used to determine land-use changes for Kyoto carbon accounting.

As a finitist analysis suggests, each accounting classification of 'tree' or 'non-tree' is a decision rather than simply the application of data to such categories. The application of this data into carbon accounting categories has important limitations because common vegetation – grasslands, sparser woodlands, shrublands, wetlands and (other) areas – are smaller targets than the coarse resolution Landsat technology can reliably record (Bartel, 2004: 326). Although this limitation is widely known (it is, for example, taught to first-year Remote Sensing Applications students at UNSW) the high costs and effort involved in upgrading to more sensitive equipment meant that 'Legislative protection as well as monitoring has been "very much on the side of the trees" to the detriment of other natural areas' (Bartel, 2004: 326). These technological limitations mean that the distinction between trees and non-trees that is crucial to determining LULUCF figures – and hence a party's target for reducing industrial emissions – requires interpretation of spectral outputs.

SLATS and the political economy of land clearing

The withdrawal of state financial and logistical support and other incentives to clear native vegetation began in the mid-1980s. Up until this time, state governments had actively encouraged landholders, most notably beef cattle farmers, to regularly clear their land in order to maximize productive output, even imposing penalties for *not* clearing land (WWF-Australia, 2003; Kuhnell et al., 1998; Whelan and Lyons, 2004; AGO, 2002a).

The shift in economic priorities was a result of a number of factors, including a steady decline in agricultural outputs and the growing environmental consciousness of urban populations reflected in the social movement campaigns outlined above (AGO, 2002a). By mid-1997, the NSW government had tabled legislation banning land clearing. Queensland followed suit early in the new millennium[19] after negotiating

a compensation agreement with landholders. The passage of NSW Native Vegetation legislation[20] was seen as a key victory for the savvy Premier Carr. However, its enforcement has been a contentious issue. Curtailing land clearing was not simply a matter of gathering facts. It involved removing key responsibilities for managing the land from property holders, many of whom had strong identities based on the pioneering spirit of efficiently using the land. Although legal recognition of the responsibilities associated with property rights is not new,[21] the view that the landholder is free to do as he or she wishes on the land has been eroded by an acknowledgement that their actions may have consequences outside the boundaries of their property (Gunningham et al., 1998: 238).

The Queensland State Land Use and Tree Survey website boasts that it is 'not a desk project. The scientists that process the imagery for a particular satellite scene also personally ground truth and validate the computerised classification of each scene no matter where it is in Queensland'.[22]

The SLATS team have made their assessments about threshold levels public (Kuhnell et al., 1998). Demands to make analogous NCAS assessments visible to enquiring civil experts has formed the basis of contestations of its objectivity (Hamilton, 2007; Hamilton and Vellen, 1999). Macintosh argues that although the data are not directly comparable, the trends in the clearing

> should be roughly similar. Further, given the nature of the differences between the accounting systems, it is unlikely that the differences in clearing numbers should be as large as they are. Moreover[,] ... after adjustments to account for the major definitional issues, the data should be very similar, which they are not. (Macintosh, 2007a: 24)

In summary, Macintosh made an issue public. He mobilized a social group around classifications of land clearing, contested comparable models using alternative data, and opened the black boxes of Australian Kyoto. For Macintosh (2007a) the critical questions are whether these methods are 'defensible from a scientific perspective', and whether the results accurately reflect 'what has occurred on the ground'. He notes that the methods used by both NCAS and SLATS have been subject to peer review, and both programs also employ quality assurance and quality-control measures to ensure the accuracy of their outputs. 'However, one important difference between the two is that SLATS has had [an] extensive field verification process' (Macintosh, 2007a: 19). Thus, Macintosh argues:

> Australia has an obligation under the UNFCCC to ensure that the information that it submits for the purpose of the convention is accurate and verifiable. Further, as the Federal Government has publicly committed to ensure that Australia meets its Kyoto target, it has an obligation to ensure that the information that it publishes on this issue is as accurate as possible. The fact that the Queensland Government has taken steps to reduce land clearing is not a sufficient reason to ignore the anomalies identified in the NCAS data. (Macintosh, 2007a: 19)

Other specialists have found NCAS data too unreliable for other applications. Forests NSW had been using aerial photos to capture specific data of project areas to assess their eligibility for Kyoto forestry credit. Their officers found differences between what the AGO analysis claimed was happening and their aerial photographs. As documented in the previous chapter, these photos allowed the officers to draw lines around where the trees are to within 2m. Where they could not use Lands Department photographs, Forests NSW commissioned their own aerial photography. This was conducted around populated areas and used for different kinds of land management and planning purposes. NCAS was considered as a candidate for auditing of which forests would or would not be eligible to generate offset credits under the Kyoto definition of forests. One forests officer intimated to me that a 10,000 ha sample area was analysed and found to match only 60 per cent of the aerial photographs for the baseline year.

These challenges highlight in two ways the value of finitist and sociologically informed approaches to the construction of data sets. Firstly, they show how definitions of 'deforestation' for NCAS were produced within sufficiently broad parameters to meet the demands of the expert review processes of the UNFCCC (UNFCCC, 2009). This report from a UNFCCC Secretariat team of expert reviewers ultimately serves to satisfy verification processes specified within the Kyoto Protocol rules. Furthermore, the Department of Climate Change (successor to the Greenhouse Office) responded to Macintosh's challenge by conducting 'boundary maintenance' in a number of ways. These include arguing '[t]he Queensland SLATS program and the Australian Government's National Carbon Accounting are set up for different purposes, have different reporting requirements, and have significantly different technical methods' (Macintosh, 2007b). This criticism is intended to work as a kind of 'boundary maintenance' for the LULUCF expert community; however, it also underlines the deeply political nature of biomass accounting.

Towards a politics of classification

Data do not speak for themselves. They must be *made* from models, instruments, standards, tests and institutions to give meaning and answer problems. Regulatory data are gathered according to particular socio-material constraints, such as prevailing laws and available technologies. As I have shown, coordinating this data in a way relevant to accounting for land-based carbon sinks requires judgements. The fact that these judgements are devised to construct baselines and monitor changes suggests that a global carbon market will not be framed by representations of nature, but rather by economic expedience and political judgement. MacKenzie and Callon argue that the tractability of credits themselves may translate into a global market if concerns about the framing of carbon accounts are accommodated. Under the UNFCCC, the verification of carbon accounts is embedded in networks of expert review rather than subject to the wide-ranging witnessing urged by Callon (2009). In practice, the UNFCCC process has meant that allocation of reviewers by the Secretariat has been subject to accusations of conflict of interest because of the enormous financial consequences of LULUCF accounting.

What one interviewee described as the 'cottage industry' of verification of national carbon accounts will face much greater scrutiny if a successor to the Kyoto Protocol is to be negotiated at all. Nevertheless, the expert communities within the UNFCCC have thus far proven to be highly resistant to reform. It is not clear that the Australian civil society challenge to the veracity of the 1990 deforestation baseline has had material effect on the international negotiations. Parties are all too aware of the in-principle flexibility of rule-following; thus, as one Australian LULUCF negotiator put it, an important part of 'the game is to make sure other parties pay more than you'.

This quip shows the importance of maximizing the nation state's *economic* position. However, this does not mean accepting at face value the international realist accounts of negotiations and their privileging of neo-liberal economic subjects. Realists have shown how policy commitments reflect the economic and political projections of nation states. Further, they tend to take for granted the techno-scientific representations of the climate and carbon fluxes. Thus, rather than attending to the political negotiation of processes of measurement, they have documented how blocs of countries have grouped themselves in terms of a shared economic interest in framing the scope, source and responsibilities for the problem of greenhouse emissions.

This concept of the development of a climate agreement as a function of politics dictated by economic interest is exemplified by Victor and Keohane (2010). They argue that the political negotiation of a climate-change mitigation agreement can be located on a spectrum from fragmentation of parties to all-inclusive negotiating party blocs based upon their shared economic interests. According to the authors, the result of varying, overlapping degrees of fragmentation on different issues is a 'regime complex': a loosely coupled set of agreements about such issues as financing arrangements for developing countries or a deforestation reduction mechanism (Victor and Keohane, 2010).

The dynamics of these regimes and the negotiating blocs that determine them, Victor and Keohane argue, can be understood in terms of the functional, strategic and organizational inadequacy of a comprehensive agreement. The functional component refers to the prohibitive complications with framing, *ex ante,* the different 'complexes of interests, power, information, and beliefs' (Victor and Keohane, 2010: 14) into a single arrangement. At a strategic level, they argue that 'the benefits of a comprehensive regime may not seem sufficient to justify the bargaining efforts and concessions that would be required' (Victor and Keohane, 2010: 14). The path-dependence and organizational practices associated with measuring and reporting emissions, the authors argue, correspond with the fact that different countries and sectors have 'become interested in serious action on climate change at different times. When the timing of action varies, the 'leaders' construct partial institutions that suit their purposes and their interests (Victor and Keohane, 2010: 15).

Victor's and Keohane's concept of a 'climate regime complex' incorporates a mix of normative and descriptive elements. For example, they suggest that 'regime complexes are not just politically more realistic but they also offer significant advantages such as flexibility in substantive content and scope' (Victor and Keohane, 2010: 2). They also suggest that 'efforts to create an integrated, comprehensive regime are unlikely to be successful and may even divert attention from more practical efforts to create regime complexes'.

This understanding of all aspects of national policy measures as the instrumental extension of the interests within nation states is theoretically appealing but overlooks two crucial factors addressed in this chapter. Firstly, it overlooks civil society and other independent actors within nation states who may contest policy measures. These actors may dispute the principles of economic interests upon which national actors pursue their goals implicit in Victor's and Keohane's model, instead using rights-based discourses of carbon emissions allocation as

Hamilton (2007) and others have done. Secondly, it leaves 'black-boxed' the practical challenges faced by climate diplomats of 'moulding global flows of carbon onto territorial ground' (Lövbrand and Stripple, 2009: 4). In other words, the emphasis on national interest underpinning realist models 'black boxes' the technological formations within which knowledge of carbon accounts are embedded and negotiated.

Leaving technologies as exogenous variables in favour of pre-existing interests obscures the materially distributed ways humans think about and act upon the climate. Taken to its logical conclusion, realist perspectives imply that all measures simply reflect the dominant industrial interests of their respective nation states, thereby obscuring the work of translation between national interest, technical practice and verification that comprises national carbon accounting. Rather, I have shown that the frames which state economies operate do not simply reflect some pre-existent set of interests, but constitute a shifting assemblage as new problematizations emerge from civil society, often across different scales of jurisdiction. 'Big' actors in climate negotiations, like nation states, rely upon and are configured through black boxes to measure sources and sinks of emissions. Measurements can become politicized but are not inherently so in the way realists' discourse assumes. The multiform dynamic of problematizations expressed in Callon's ideas of 'civilizing markets' is intended to disentangle notions of scientific authority from state-appointed scientific bodies' expertise. This can only occur through collective experimentation which recognizes that scientific questions such as land-use figures cannot definitively be separated from political questions such as a party's emissions-reduction target.

The sheer complexity of land-based carbon-sink governance, that is, the many different ways disciplinary approaches are devised to construct baselines and monitor changes, presents a number of barriers to a global carbon market. MacKenzie and Callon argue that the tractability of credits themselves may translate into a global market if such concerns are accommodated. The 'civilizing markets' thesis assumes, optimistically, that the labyrinthine character of carbon accounting can be overcome by a commitment to revising the distinctions between the scientific, economic and political.

The case presented in this chapter requires carbon accounting rules and frameworks to be understood as a site of economic competition, rather than a reflection of accurate scientific representation as rationalist and realist discourses assume. Discourses of economic efficiency extend to the writing of rules and to accounting decisions about objects such as trees. Data do not speak for themselves. They must be *made* from

models, instruments, standards, tests and institutions to give meaning and answer problems. Regulatory data are gathered according to particular socio-material constraints such as prevailing laws and available technologies, which have historically been deployed in the service of demarcating national territories – their 'inside' and a global 'outside'. The land-use change data that forms Kyoto Protocol carbon accounts are not a 'view from nowhere' but a peculiar view of national jurisdiction. Existing institutions of verification continue to overlook this particularity and the conflicts between data generated at different scale.

Understanding how liberal governmental *agencements* operate with capital to make measurement and counterfactual conjecture is a necessary first step in building a politics of classification. Criticizing the imprecision of carbon accounts because of the insufficient resolution of images obscures the ways social interests are embodied in research programmes and technologies to measure carbon. The assembly of 'national carbon sinks' should be understood as one aspect of a contemporary neo-liberal governmental practice of monitoring, measuring, calculating and controlling human interactions with trees as conduits of a global carbon cycle.

Liberal governing also requires borders to frame transactions and populations. Economic boundaries were realized through science and politics in different forms: the sponsorship of biotic carbon surveys by mining companies, the choice of definitions for forests and trees for national carbon accounts in order to minimize costs, and by civil experts who mobilized 'counter-publics' based on a different vision of Australia's obligations with its industrial emissions.

5
‘Economists in the Wild’: Clean Development and the Global Politics of Carbon Offsets

Joint Implementation and the Clean Development Mechanism (CDM) were the key offset mechanisms developed following the Kyoto Protocol negotiations. They emerged in the year 2000 as a compromise between the industrialized countries’ fear of costly mitigation targets and developing countries’ demands for technology transfer, development aid and an insistence that financial penalties be imposed on any industrialized country that exceeded its emissions targets.

Interest in the Clean Development Mechanism only increased significantly in 2005 when the European Union’s emissions trading scheme commenced in 2005 and the Kyoto Protocol entered into force with Russian ratification. The CDM is a baseline-and-credit scheme like the NSW scheme; though unlike NSW GGAS, the CDM includes a financial additionality test. That is, projects must demonstrate the necessity of CDM funding before a project will be financed using an approved methodology.

The lack of a successor agreement to the Kyoto Protocol has effectively extinguished demand for credits. A large number of projects were rushed through in 2012 at the end of the first commitment period, whilst the CDM executive board commissioned reports on the scheme’s performance (see especially United Nations, 2013). What is at stake in these evaluations is the credibility of governing tradable credits beyond the level of the nation state or region. For example, Callon contrasts the CDM with the European cap-and-trade approaches, whereby the latter exemplifies his call to ‘civilize markets’ because the participants have constructed a multi-phase emissions trading scheme (ETS) that deploys ‘networks of experimentation’ (Callon, 2009: 538). These networks are

typified by 'critical reflection [upon the great uncertainties that characterize the scheme], negotiation, ongoing evaluation, and learning by doing, using and interacting'. He suggests that this logic of tentative reflection also operates with the CDM; however,

> unlike [European] emission permits, these new 'products' do not seem to be the outcome of prior intense theoretical reflection. As fruits of the imagination of innovators in the wild seeking a compromise between the demands of the US and those of developing countries,[1] they are perceived as forms of experimentation that are fiercely criticized and trigger numerous counter-proposals.… All in all, carbon markets seem to be experimental objects, all the aspects and components of which are tested, reflected on and critically evaluated. (Callon, 2009: 538)

This chapter critically assesses Callon's claims about the civilizing potential of CDM. Drawing on a number of case studies and documentary analysis, I examine how economists mediated competing demands on carbon offset rule-making and verification. These include: cost demands from rich countries; demands for environmental integrity from civil society groups; and demands for a contribution to economic development from host countries. These competing demands mean that offsets must be justified according to multiple criteria, rather than valued according to measures of cost and efficiency. The chapter draws attention to the 'prior intense reflection' in the design of Activities Implemented Jointly (AIJ) – the forerunner to the CDM. 'Prior intense reflection' required projects to be able to be justified in more ways than purely economic efficiency – that is, in terms of the cost of the project per tonne of carbon emissions reduced. However, financier and host countries needed projects to be justified according to incommensurable orders of evaluation – their 'civilizing' potential and their market cost (cf. Stark, 2009). These different, parallel forms of valuation meant that international offsets operated as 'boundary objects' (cf. Star and Griesemer, 1989) in international negotiations, facilitating and harmonizing different organizational rationales and objectives.

However, the justification of a project's worth – its role in national civic life, in the development of industry, and also measurable economic cost – was obscured when economists sought to sever the 'Gordian Knot' between politics and economics by devising rules capable of transforming project evaluation into a process of quantitative assessment. The tendency to treat economics as apolitical has seen the continual

return of 'repressed' content which results from treating what Callon calls a 'hot' situation as if it were 'cold' (Lohmann, 2005). This dynamic of repression and overflow identified by Lohmann can be traced to the promise of a science of baseline emissions data against which reductions could be assessed, rather than representing the extension of a capitalist logic of commodification as Lohmann claims. This chapter, instead, shows that the rationales for the first international offsets were heterogeneous and not reducible to corporate interest.

The chapter proceeds as follows: First, some essential background material on flexible mechanisms is provided, reviewing how the development of AIJ expressed the US and the 'Umbrella Group's' insistence on a fully flexible, 'comprehensive' policy approach to the sinks and sources of emissions. I draw attention to two crucial consequences of the comprehensive approach. It brought closure to debates about Global Warming Potential (GWP), a decisive component of the 'geo-economics' pursued by the US negotiators in conjunction with other industrialized countries. Another consequence was the presentation of economic expertise as a science of technological decision-making. Using the case of a coal-to-gas boiler substitution program in Poland, it examines how the rhetoric of baseline determination was used to perform the notion of cost-effective emissions by transforming what were otherwise policy decisions into questions of technical and economic efficiency.

Second, this chapter examines the 'chimera' (Grubb et al., 1999: 230) of an objective economic baseline constructed by a group of economists and institutionalized in the CDM project assessment cycle. Three project categories are examined, where the interpretative flexibilities and administrative structure of the project cycle have been contested by civil society actors. These are: HFC-23 destruction projects; supercritical coal; and wind and hydro projects. These three cases illustrate a failure to create a neo-liberal 'science' of the carbon economy whereby baselines are developed independently of politics. Rather, this separation merely served to displace the politics of technological decision-making into the processes of making baselines, assessing additionality and validating projects.

Thirdly, counter-proposals to enhance legitimacy throughout the project cycle are discussed. The argument is that these will serve to fragment the market for CERs, a process that has already begun. The chapter concludes with a discussion of the politics of quantification and qualification raised by the development of the CDM. Carbon-offset governance trading requires an experimental ethos outlined by Callon with appropriate institutional processes to ensure that multiple orders

of evaluation can be kept in play. One such process is discussed: procedures to secure the 'input legitimacy' of those affected by carbon offset projects through advanced consultation. The chapter concludes with a discussion of what is at stake in such procedures.

Global governance and 'radical principles' of flexibility

The initial proposals for 'Activities Implemented Jointly' (AIJ) were put forward by Norway in the lead-up to the negotiations of the 1992 Framework Convention. The oil- and gas-rich[2] Scandinavian nation was backed by the Netherlands and the United States, who were designing the SO_2 allowance scheme (described in Chapter 2) at this time. AIJ operated as a 'laboratory for the CDM' (Michaelowa, 2002: 3). A number of links between the two mechanisms are evident. First, AIJ established a set of principles various countries could use to develop projects that could be compared globally according to the cost of abatement. Such comparisons required large, powerful bureaucracies to determine credit production. Second, flexible mechanisms were jointly developed with the 'black boxing' of the global warming potential of methane, nitrous oxide (N_2O) relative to that of carbon dioxide. Economic principles of international flexibility and the calculations of GWP were mutually reinforcing through the negotiation of the Kyoto Protocol (MacKenzie, 2009a).

Third, the AIJ pilot established a community of policy entrepreneurs who assessed and developed measures of emission baselines in developing countries. They established tests against which the likelihood of a project going ahead could be assessed; and reinforced discourses of the uniformity of economic development by establishing standards against which a project's contribution to it could be assessed. Fourth, AIJ was also crucial to developing formal (legal) and informal relations between governments, financiers, and observer organizations. Finally, it provided an opportunity to assess reporting and verification requirements to produce sufficiently plausible 'output legitimacy' for a market-based mechanism to reduce emissions. Each of these elements constituted the practical and epistemological framework for the CDM.

Norway's proposal reflected the commercial interest in extracting the significant oil reserves within its territory and advancing the radical agenda of the incumbent Prime Minister Gro Harlem Brundtland's government (Andresen and Agrawala, 2002). In the late 1980s, the Norwegian government officially expressed ambitions to lead the process towards establishing an international climate-change regime (Bergesen et al.,

1995). In 1989, buoyed by successful lobbying on acid rain and anti-ocean dumping campaigns, Brundtland led Norway to adopt a unilateral emissions-stabilization target by the year 2000. She had been a strong advocate of international emissions-stabilization targets the year before in the lead-up to the Toronto Conference, as well as chairing the World Commission on Environment and Development (Agrawala, 1999). Brundtland called for new international institutions with non-unanimous decision-making, 'in effect a partial renunciation of sovereignty' (Andresen and Agrawala, 2002: 338). She stated at the time that 'the principles ... are in fact very radical, but anything less would not serve' (Andresen and Agrawala, 2002: 338). As negotiations of the Framework Convention proceeded, the option for 'joint implementation' became a precondition for Norwegian participation in an international agreement (Andresen and Agrawala, 2002). Norway pushed for a further elaboration of joint implementation at the first Conference of the Parties (COP) to the FCCC in Berlin in 1995 and the parties agreed:[3]

- To introduce a Pilot Phase for activities implemented jointly among Annex I Parties and, on a voluntary basis, with non-Annex I Parties that so request it;
- That activities implemented jointly should be compatible with and supportive of national environment and development priorities and strategies, contribute *to cost-effectiveness* in achieving global benefits and could be conducted *in a comprehensive manner* covering all relevant sources, sinks and reservoirs of greenhouse gases;
- That all activities implemented jointly under this Pilot Phase require prior acceptance, approval or endorsement by the governments of the Parties participating in these activities;
- That activities implemented jointly should bring about *real, measurable and long-term* environmental benefits related to the mitigation of climate change that *would not have occurred in the absence of such activities*;
- That the financing of activities implemented jointly shall be additional to the financial obligations of Parties included in Annex II to the Convention within the framework of the financial mechanism as well as to current official development assistance (ODA) flows;
- That no credits shall accrue to any Party as a result of greenhouse gas emissions reduced or sequestered during the Pilot Phase from activities implemented jointly. (my emphasis)

Two aspects of schemes discussed in previous chapters are notable with regard to this set of rules. Firstly, these rules stipulate that AIJ should be

real, measurable and counterfactual (that they 'would not have occurred in the absence of such activities'). The tension between measurement and counterfactual estimates has been examined in earlier chapters, such as in Chapter 2 where the Environmental Defense Fund used counterfactual cost projections to justify the market in sulphur permits. Such projections were crucial for translating the social valuation of ecosystem protection into market prices for sulphur permits.

Carbon offsets, unlike cap-and-trade permits, have very specific attributes associated with their commodification. As demonstrated in Chapter 3 with reference to the Demand Side Abatement project in the NSW GGAS, a carbon reduction commodity (emissions reductions by substituting energy-efficient light bulbs) was not easily communicated and justified by Easy Being Green according to recognizable social categories. Project proponents under AIJ faced a similar problem to other carbon offset providers that is, to transform mundane technologies into climate-change mitigating devices.

Securing economic counterfactuals

The difficulty for carbon offset production lies both in its material complexity and its reliance on counterfactuals. Carbon offsets are socio-material *agencements* in the sense that the price of greenhouse-gas abatement requires a variety of intermediaries to mediate willing users, financiers, project managers and local residents. 'The material nature of technology's engagement with the atmosphere ... plays a crucial role in the effective commodification of [tonnes of CO_2 equivalent] and its ability to be incorporated into carbon standards of differing levels of rigour' (Bumpus, 2011: 616). Technologies here refer to the various monitoring and reporting devices mobilized by 'economist in the wild' project developers. For example, in Chapter 3, forestry offsets required photographs and complex computer modelling to meet the standards required by regulators and market participants. If the forest offset projects satisfied these rules and attained the status of facts, they would create both a value out of carbon dioxide sequestered in trees and be negated by the emission of carbon dioxide elsewhere.

The first experience with AIJ pilot projects demonstrates that economists' effective enrolment of technologies is only one aspect of the effective commodification of carbon standards. They are subsidiary to wider political considerations of nation states and the management of their economies. Norway had already struck an agreement with the World Bank on co-financing worth US$4.8 million for two initial projects, which were formally registered with the UNFCCC in 1996. The first of

these was the Poland/Norway Coal-to-Gas Conversion – AIJ Pilot Project. The World Bank used the lessons learned from the project in seminars and workshops and to guide debate about monitoring and reporting systems and the scope of crediting mechanisms more broadly (Heister et al., 1999: 262). Its successes and failures were, therefore important to the development of the CDM Project Development cycle (outlined below). The objective of the project was to convert 30 non-industrial small to medium-sized heat plants (boilers) from coal to natural gas in residential houses and public buildings. The project also aimed to undertake measures to 'improve heating efficiency' by modifying the heating equipment in homes. According to the project documents:

> One of the widespread uses of coal in Poland is space heating. The use of gas for space heating was earlier prohibited and the use of oil was held back by various measures. The aim was to limit foreign exchange expenditures on energy imports. (Leiro et al., 1997)

Leiro et al. also construct a scenario to justify carbon finance:

> In the absence of the total project, reengineering and replacement of existing coal fired boilers only at the end of their service life would be the most common choice of boiler owners due to a low investment price and the familiarity with coal technology. A shift to new coal fired boilers was chosen as the baseline knowing that this is a conservative choice for calculating the probable emission saving. The abatement effect is thus the difference in emissions between new coal-fired boilers and new gas-fired boilers. (Leiro et al., 1997)

The project proponents asserted that the economic barrier to the implementation of these newer boilers could be represented by the Krakow site, indicative of the 'perhaps 40 different sites' where the new boilers would be installed (Leiro et al., 1997: Section D). The Krakow boiler owners assumed the 25 per cent target Internal Rate of Return would not be met without a grant finance of 'about 34 per cent (or US$130,000)' (Leiro et al., 1997: Section D). These approximate figures of commercial viability were important framing devices for the project; however, no justification is provided for their selection; it is simply implied that these are expected market returns.

The second challenge was to calculate the emissions saved from the conversion. This calculation involved estimates about emissions rates of coal and gas burning respectively. Chapter 2 showed the key

challenge for proponents of the sulphur dioxide scheme was ensuring the 'facticity' (MacKenzie, 2009b: 8–19) of the measurement of emissions. This meant installing devices directly on stacks rather than the simpler 'mass balance' approach. As a pilot project, however, the project developers simply assumed that emissions from black coal mines in Poland average 20–25 m^3 per tonne of coal produced. Taking the margin between the cost and emissions estimates, the cost of CO_2 abatement per tonne was created, and was expressed as the 'marginal cost of abatement' per tonne of avoided CO_2. This transformation of assumptions, measurements and estimates into a carbon price took place underneath a narrative highlighting the environmental benefits of gas technology, which links the ambitions of project developers to Polish national development. They suggest that the introduction of gas technology will 'facilitate the Government's efforts to pursue its environmental priorities and standards aggressively and to take full advantage of the macroeconomic conditions and other incentives that induce energy efficiency and conservation' (Leiro et al., 1997). They suggest a broader liberalization of energy pricing and an enforcement regime of fines that would make the transition from coal-powered to gas-powered systems a 'self-supporting' option, as the 'true costs of environmental damage' are made visible. The project proponents hoped that, once successfully demonstrated in Poland, the project would be 'replicable in the large number of coal-dependent/intensive transition economies that have access to gas supplies' (Leiro et al., 1997).

The main development of the AIJ pilot phase was to establish and consolidate a 'community of AIJ project developers' (Michaelowa et al., 1999) who advocated a crediting mechanism. This group aimed to arrange things so that once projects were recognized through the UNFCCC as offsetting the targets of financier countries, the incentive to create new baseline methodologies and projects in host countries would fill in the institutional and metrological shell constructed during the Pilot Phase. For example, the use of internal rate of return reporting to justify the Polish coal-to-gas project was a precursor to the barrier analysis of the CDM project cycle.

Economists exploited uncertainties about the role of offsets in international negotiations by devising ways of justifying projects beyond cost. In practice, the social and technical requirements of project development laid out in the international agreements were interpreted in very different ways by both investor and host countries. Proponents of a crediting mechanism invoked incommensurable cultural and economic justifications. On the one hand, the hope was that project development

would be streamlined if relationships and procedures could be built up over time. Some governments had memoranda of understanding to formalize these relations. Economists have often also alluded to the civic virtues of building such partnerships (see especially Chapters 2 and 10 in Dixon, 1999; Michaelowa, 2002; Richards and Gale, 1996). On the other hand, the imperative of cost-effectiveness assumed that multiple avenues for trade would seek out the 'lowest cost abatement opportunities' (Harrison and Rutherford, 1999). A community of project developers formed during the 1990s, building institutions and social ties in host countries (Michaelowa and Dutschke, 1999). The inertia of networks and learning between countries meant that most financiers sought out and strengthened existing bilateral ties rather than risk potential cultural misunderstanding with newly formed project partnerships (Michaelowa, 2002) as a rationalist analysis of pursuing 'least cost abatement' would imply.

An extensive body of literature analysing projects registered under AIJ emerged during the project's lifetime (see especially Schwarze, 2001; Michaelowa, 2002; Dixon, 1999). This literature demonstrates that projects whose GHG reference was CO_2 dominated AIJ, as Figure 5.1 (adapted from Schwarze, 2001) shows. These included forestry and wind power and avoided deforestation projects in Costa Rica, energy-efficiency projects such as the Norway Poland Coal-to-Gas Project, and a Norway-Mexico energy efficient lighting substitution project similar to the one documented in Chapter 3 under NSW GGAS. In addition, the nitrous

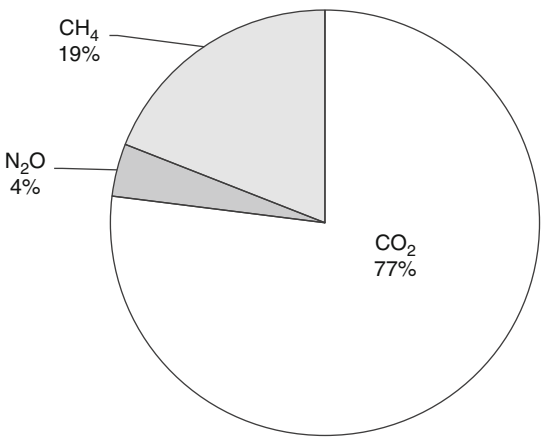

Figure 5.1 Share of AIJ projects by GHG type

oxide share of GHG reductions was the result of just one agricultural project in India (Schwarze, 2001). The commensuration of methane and N_2O projects relied on the authority of the Intergovernmental Panel on Climate Change (IPCC) definition of Global Warming Potentials, as discussed below. Finally, AIJ formed a community of project developers, NGOs, governments and banks (the World Bank in particular) that created an international vocabulary about emissions reductions, baselines (Michaelowa and Dutschke, 1999) and 'capacity building' (Heister et al., 1999) that enabled the prospects of emissions reduction credits in different countries to be assessed according to a common set of criteria: the marginal abatement cost. In this way, economists attempted to construct the institutions that would enable a global carbon price to be discovered.

Economic counterfactuals as anti-political

Arguably the key victory in the development of AIJ was the presentation of energy policy as a technical matter that could be optimized by expert calculations. In reality, AIJ required expert judgements about a number of social and economic factors, each needing to be compatible with the wider strategies of the host nation state. Governmentality scholars have shown how seemingly technical judgements about health policies are in fact decisions to promote a particular 'form of life' (Dean, 2007). In development discourse, this promotion occurs through a number of assumptions about technology use and the boundaries of economic rationality. For example, the assertion that the Polish pilot project was both a financially attractive proposition and unable to be financed by the boilers' owners was also an implicit judgement about whom the owners could approach as possible creditors, the scope of that credit and what technological choices were available to them. The project documents tell a Promethean narrative, whereby the unleashing of *homines economici* from their regulatory shackles would create an environment in which boilers acted as a 'catalyst to stimulate self-replicable technological and institutional changes' (Leiro et al., 1997), if only the government would liberalize fuel supply and remove information barriers to the uptake of energy-efficient lighting, heating and windows.

The rhetoric of a baseline in which coal-fired heating was the preferred choice was a frame that excluded other political and economic considerations. For example, the liberalization of coal prices had been postponed due to fears of its inflationary effects, as well as union politics with the restructuring of heavy industry in the post-Soviet era (Tatur, 2004: 262–278). The Polish pilot project demonstrated further shortcomings.

Without the consent of the end users of equipment or those employed in the maintenance of existing facilities, the project failed to meet its target number of new boilers. The World Bank commissioned an evaluation[4] of the Polish coal-to-gas conversion project in 1999. The subsequent report criticized long delays and ongoing problems with the Polish Ministry of Environment, the local consultants and the Polish Environment Fund (Selrod et al., cited in Michaelowa, 2002). Only one of the 40 boilers had actually been converted (Selrod et al., cited in Michaelowa, 2002). The Polish project was typical in this regard: most project reports were incomplete or misleading and projects simply went unchecked by host-country authorities, or when they did, insufficient data was provided to allow a reliable assessment of what had been achieved (Michaelowa, 2002). To attain 'the transparency necessary' for a well-functioning CDM, market proponents concluded that 'a big step forward' had to be made (Dixon, 1999). However, it was not the 'transparency' implied by correctly reporting projects that progressed the CDM; rather, it was a felicitous combination of international politics, the 'black boxing' of the concept of Global Warming Potential and the determination of economists to 'sever the Gordian Knot' between politics and economics. These will be considered in turn.

'Black boxing' Global Warming Potential

The concept of GWP allows for projects that reduce different gases to become tradable. The IPCC expresses GWP as an index 'which allows the climate effects of the emissions of greenhouse gases to be compared. The GWP depends on the position and strength of the absorption bands of the gas, its lifetime in the atmosphere, its molecular weight and the time period over which the climate effects are of concern' (Houghton et al., 1990: 45). This is expressed as a formula to which the gas in question is indexed according to its effect on the radiation balance at the upper and lower atmospheric boundary (tropopause), measured in watts per square kilogram. Its estimated lifetime is modelled according to a complex set of scenarios in which temperatures at different parts of the atmosphere have been adjusted in different ways (MacKenzie, 2009a: 446). The decision to allow methane[5] – CH_4, whose GWP = 24.5 according to the Second Assessment Report IPCC Assessment, the number conventionally used for CDM project trades (MacKenzie, 2009a) – and Nitrous Oxide (N_2O, GWP = 310) reducing projects in AIJ was a crucial expression of confidence in the authority of this claim. CH_4 and N_2O were two of only 19 gases for which the IPCC felt able to offer GWPs estimates in 1990. Both the notion of 'global warming potential' and the IPCC's

mid-1990s estimates of GWPs were then decided at the first Conference of the Parties[6] to the UNFCCC, thereby establishing the concept of CO_2-equivalent. As Shackley and Wynne (1997: 97) argue:

> Without GWPs, the comprehensive approach would just not be feasible, and a 'carboncentric', command-and-control type regulatory regime would have become more credible, a politically unacceptable alternative for the US government. In this political context, some ambiguity in the precise technical meaning of GWPs serves an important function, since it allows the implication to be made that the GWP is a measure of the response as well as of the [climate] forcing. This in turn lends support to that policy response – the comprehensive approach – which is most politically desirable.

By 1991 the idea of controlling all sources and sinks had acquired a 'hegemonic status' amongst US government agencies such that 'the efficiency advantages of the comprehensive approach as compared to the irrationality of considering constraints on single gases' would not be considered in any agreement containing single gas targets (Grubb et al., 1991: 348). Recognition of a 'comprehensive approach' was also a tacit acknowledgement that market-based instruments would in the future play a key role in letting US firms engage in climate mitigation domestically and also internationally (Matsuo, 2003: 193). The combination of climate forcing and policy response in GWP identified by Shackley and Wynne is important here because earlier IPCC reports had separated the two, thereby precluding a policy response (Shackley and Wynne, 1997). Multiple customized time horizons for projects would prevent trading of credits relating to industrial facilities producing different gases, thus weakening the rationale for a global agreement on GHG emission reductions (Brown et al., 1993). In this way, debates about a comprehensive approach gave rise to debates about sovereignty, US imperialism and 'supplementarity' – the extent to which offsets should be 'supplementary' to a nation's sovereign mitigation policies.

Controversies over expert reports regarding damage estimates of climate change leading up to the negotiation of the UNFCCC brought these questions to the fore. For example, the World Resources Institute's Greenhouse Index and Nordhaus (1991) were intended to aid policymakers by providing a snapshot of the top nations' annual emissions and of both the damage and mitigation cost functions of global warming. Choices of time horizons and discount rates were the subject of considerable debate at this time as the institutional foundations of the

Framework Agreement were negotiated (Grubb et al., 1991; Agarwal and Narain, 1991; Shackley and Wynne, 1997). Insofar as they all sought to meet policymakers' demands for lowest-cost mitigation strategies, these actors served to 'black box' GWPs. Indeed, GWPs remain 'black boxes' in much of the policy and economic debate. However, GWP estimates are acknowledged to be subject to uncertainties of the order of ±35 per cent (IPCC, 2007b). By 2007, for example, the consensus estimate of the global warming potential of HFC-23 had increased from 11,700 to 14,800.

However, as MacKenzie (2009a) has argued, the factual status of GWPs rests upon the (social) authority of the IPCC and demands for the lower costs provided by a liquid carbon offset market for industrialized countries. The 100-year reference point for CO_2-equivalence is essentially a convention used for the purposes of making gases commensurable. This convention has been challenged during negotiations under the Conference of the Parties. For example, during UNFCCC negotiations in 2009, Brazil argued that 'the adoption of the GWP leads to [sic] the wrong signal when establishing mitigation strategies. This is particularly important when Parties converge to establish temperature increase thresholds (e.g. 2° Celsius) as a goal. The GWP shortcomings have been clearly identified in relation to CDM project activities that burn methane-producing CO_2. The real benefit for the climate in terms of temperature increase would be four times less than the Certified Emissions Reductions (CERs) it generates'.[7] However, such controversies over metrological uncertainties and time horizons have yet to spill over from COP negotiations into the operation of carbon markets. Instead, the Second Assessment Report figures have been simply replaced with the Fourth Assessment Report figures at the recent Durban Conference of the Parties, and the limitations of the GWP approach are officially noted in the COP decision.[8]

The birth of the CDM

In the four years of negotiations before the main operational guidelines of the CDM were agreed upon in November 2001 in the Marrakech Accords,[9] economists were at the forefront of negotiations about project rules and parameters. Ironically the withdrawal of the United States from the Protocol with G.W. Bush becoming president in 2001 allowed decisions to be made on the institutional form of the flexible mechanisms that the United States had previously negotiated so hard for (cf. Grubb et al., 1999). The four-year lead time of the Marrakech Accords was also due to issues such as disagreements about land-use

change accounting rules discussed above and in Chapter 4. These fundamental differences between the United States, the EU and others on the translation of 'comprehensive coverage' of sources and sinks not only hampered the development of the CDM, but brought about the collapse of broader negotiations at the COP6 in The Hague (Grubb and Yamin, 2000). Although the use of GWPs was instrumental in the pursuit of a 'low-cost approach', disagreements on exactly which sources and sinks could be credit-worthy effectively precluded any meaningful framing of potential costs (cf. Bodansky, 2001).

The withdrawal of the United States challenged the remaining parties in the negotiations under the UNFCCC to balance at least two competing forces. On one side, the diverse interests of industrialized countries, the AIJ project development community, and environmental non-governmental organizations (NGOs) demanded 'output legitimacy' – that is, the plausibility of credits as facts – of CDM projects. On the other side, developing countries were concerned about acceding sovereignty whilst their lowest-cost emissions-reduction projects were credited to industrialized countries. This fear that industrializing countries would only have expensive abatement when they finally came to take on targets was referred to as 'cream skimming' (Grubb et al., 1999). The introduction of a crediting mechanism – the CDM – led to an uneasy compromise between these positions.

'Severing the Gordian Knot': the politics of baseline judgements

A key development in the Marrakech Accords was the formalization of the assessment of baseline methodologies into a powerful bureaucracy. AIJ pilot projects were only required to submit their own baselines, which were reported against uniform standards by experts appointed under the UNFCCC. The Marrakech Accords formalized their powers of assessment into a series of bodies with power to decide on the eligibility of projects and the case made for their additionality. As documented in Chapter 3, a central problem for the baseline-and-credit schemes such as the CDM, economists argued, was deciding on rules that meant a trade-off between the cost-effectiveness and additionality of projects. A small but influential group of economists understood the intractable problem of entangled technical and political elements of carbon offsetting. Michaelowa (2002) thus draws upon the myth of Alexander severing the Gordian Knot[10] to describe the difficulty of reconciling baselines with the politics of additionality determination.

The myth of the Gordian Knot frequently appears in criticism of modern political thought. For Latour, it is the two strands of science

and politics that must be rethought through a Parliament of Things, rather than cut with reason (Latour, 1993; Latour, 2004). Camus's experience of French colonial devastation of Algeria prompted him to use the Gordian Knot as a rallying cry for artists and thinkers heal the wounds of twentieth-century political power (Camus, 1961).

Michael Grubb's (1999) modest analysis of the CDM is closer to this critical tradition than to the rationalist models of Michaelowa. Grubb notes that 'there may be no way of knowing whether a specific project would have gained approval without a CER'. Moreover, the idea that 'companies and governments will start doing radically new things given the incentive is ... erroneous.... Every government and every company that is actively considering the CDM is also actively considering which of their current projects, or desired proposed projects, might be able to gain crediting under it (Grubb et al., 1999: 229)'. Nevertheless, the authors argued, CDM project assessments would need to be made as part of a broader assessment of desirable public-policy goals on a piecemeal basis.

Michaelowa and his cadre developed measures that would anchor project assessments according to a number of different criteria. In the lead-up to the Marrakech Accord, a number of OECD (Ellis and Bosi, 2000; Ellis and Bosi, 1999; Ellis, 1999), World Bank (Chomitz, 2000) and further expert (Michaelowa and Dutschke, 1999) studies examined the trade-offs of different baseline construction methods. Should the baseline be determined at the level of the country or region (as with the NSW scheme discussed in Chapter 4), organized by industrial sector or individually based on each project? The group set out to address a number of issues to frame emissions reductions and create commodity units. Firstly, they were concerned about the prospect of gaming, which they defined as, 'Actions or assumptions taken by the project developer and/or project host that would artificially inflate the baseline and therefore the emission reductions' (Ellis and Bosi, 2000). Secondly, they sought transparency: '[B]aseline reports need to include information stating clearly what the situation was before the project, how this level was determined, what the expected crediting lifetime of a project is and how (if at all) the level of the emissions baseline is expected to vary over the crediting lifetime' (Ellis and Bosi, 2000: 28). Thirdly, they treated political and economic efficiency considerations as questions of competition, arguing against 'baselines that prevent the prolonging of inefficient economic structures' (Michaelowa and Dutschke, 1999: 23). Fourthly, they assumed that each industrial sector had more greenhouse-gas-efficient technological structures that should be promoted;

for example, Michaelowa (1999) cites hydroelectric and nuclear as the most carbon-efficient power-production forms.

However, abstracted calculations of the efficiency of certain energy-supply technologies were not the only consideration for constructing a market. Michaelowa also promoted a methodology based upon the availability of uniform electricity grid data to avoid accusations of bias or 'gaming' (cf. Callon and Çalkan, 2010). He was concerned about the 'gaming' risks of bottom-up baseline assessment for the sectoral (e.g., the electricity grid or aluminium sector in a country) baselines of historical emissions achieving the status of facts amongst participants.[11] Disparities in data availability relevant to baseline determination between countries and sectors[12] meant that individual project-level assessments would be necessary regardless. Therefore, a bottom-up approach was recommended.

Witnessing emissions: the political economy of the CDM project cycle

The effect of choosing project-specific baselines over sectoral or country/regional measures was to refer evaluating offset projects to administrative bodies established under the CDM executive board on a piecemeal basis. Strategies were devised to make these evaluations appear less like a decision and more like an objective assessment of efficiency. Three general definitions[13] of baselines were set out in the Marrakech Accord, which would be interpreted by a central administrative and supervisory executive board. One of the first functions of the board[14] was to establish a baseline methodology panel to interpret the 'reasonableness' of projects, the 'attractiveness' of alternatives and to evaluate 'barriers' to investment. An 'accreditation panel' was created to advise the executive board on the accreditation of third-party verifiers of CDM projects, so-called Designated Operational Entities (DOEs).

These bodies established and monitored the Project Development Cycle, which has four main components. Firstly, a Project Development Document is constructed (usually by a specialist agency), which outlines the scope of the project and justifies carbon finance. This is followed by validation and registration: the project developer must hire a DOE to vet the claims made in the Project Development Document. The third crucial component is the implementation of a monitoring plan, which must be approved by the CDM executive board. Finally, a DOE is hired to verify the project and request the issuance of CERs from the executive board.

However, the high cost of methodology development and assessment, the subjectivity of constructing counterfactual scenarios, continued reliance on 100-year GWP figures and the imperatives of cost-effectiveness embodied in this process have led to many controversial decisions about projects being granted CDM funding. The project development process costs at least €70,000 and easily over €100,000 (Michaelowa, 2009). The positivistic fears about the lack of credible validation leading to gaming have fed into a project-specific additionality criterion being used over the lifetime of the CDM, which has in turn invited gaming.

Complex sets of additionality tests[15] have been criticized as 'window dressing' by environmental campaigners. After several years of operation, numerous studies emerged pointing to the use of vague justifications such as 'tariff risk' or 'currency fluctuation risk' to pass investment barriers. The credibility of assertions that CDM projects represent genuine reductions remains subject to much greater controversy. The World Wildlife Fund commissioned a sweeping study (Schneider, 2007) that concluded that 'for about 40 [percent] of registered CDM projects additionality is unlikely or questionable'. Michaelowa (quoted in Schapiro, 2010) has doubts about 15–20 per cent of all projects. Others have reached similar conclusions (Michaelowa and Purohit, 2007; Haya, 2009; Wara and Victor, 2008). For this reason, suggestions have been made to discount CERs in regulatory carbon markets according to the number of non-additional credits generated in a trial period (Schneider, 2007; Schneider, 2009).

Crucially, for the monitoring and validation process, the only stakeholders in the cycle who visit project sites in the real world, apart from investors, are DOEs. Schneider found that prices for validation were falling, which meant that validators felt pressure to spend less time on validation and verification, to speed up the process and be flexible in their interpretation of the requirements in favour of project developers (Schneider, 2007: 20). Barbara Haya's (2009) research on the Indian project development cycle found that tacit trust relationships developed between project validators and developers, compromising their policing function. Over several years of research, including interviewing financiers, project developers, community campaigners and other interested parties, she refers to Indian validators who viewed the additionality testing procedures as a system with many 'knobs you can turn', suggesting that CDM revenues are just 'cream on the top' (Haya, 2009).

Such concerns have fed back into the administration of the CDM Project Cycle, with flow-on effects to the market price for offsets. During 2006 and 2007, the executive board added further layers to its assessment

process and ordered spot checks of Det Norske Veritas, a leading project validator. The validators had begun to realize that, with inadequate staff, assertions about the additionality of projects were largely going unchecked. Market 'regulatory risk' financiers created more elaborate contracts to hedge against price movements between the time of project submission and the verification process, which is often in excess of 12 months (Lecocq and Ambrosi, 2007). Increased scrutiny of baseline methodologies during the monitoring phase also imposed risks on CER issuance: 17 per cent of projects have had to revise and republish the Project Design Document due to methodology revision (Michaelowa, 2009).

To give a better sense of how these problems are translated into specific projects, three particularly salient project types will be explored to illustrate controversies about the scope, capacity and performance of the CDM. This leads to a subsequent discussion on the *evaluation* of carbon offsets. The suggestion is that the maturity of the market for offsets will not lead to a 'severing of the Gordian Knot' of baseline and additionality determination, but rather the gradual fragmentation of the market, as judgements about specific social and technical attributes of offset projects come to be reflected in supply and demand. The first controversy centres on high global warming potential projects referred to in Chapter 1. The AIJ phase covered just three gases, reflecting the IPCC understanding of GWPs at the time. However, the high global warming potential gases subsequently added saw new entrants flood the market with dubious credits – especially the mere 18 HFC-23 projects that comprise 34 per cent of total CERs issued (See Figure 5.2

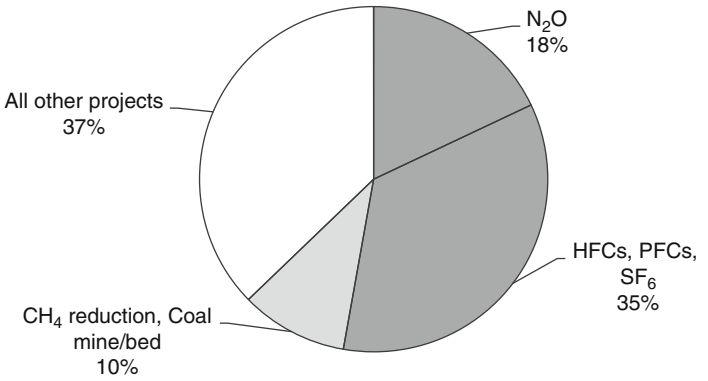

Figure 5.2 CERs issued by gas

source: Fennhan, 2015). Secondly, the CDM has been criticized for acting as a subsidy for supercritical coal projects. These have a more advanced coal-burning technology that creates fewer emissions by burning at a higher temperature. Thirdly, I examine the gaming of renewable energy projects to satisfy additionality tests.

HFC-23

The technopolitics of industrial waste-gas destruction credits highlights the fact that the comprehensive approach created powerful national sovereign entities to validate offsets. This validation is seldom explicit, indicating tacit agreement between project developers and national economic managers in host countries.

Formal challenges to the inclusion of ultra-high GWP projects have come from experts in developed countries and have been embedded in the economic politics of climate negotiations. However these challenges have often been couched in terms of environmental integrity. European states are the largest purchasers of HFC-23 credits through the EU ETS. For example, in 2007, Noe21, a Swiss non-governmental organization representing mostly European member groups submitted a formal request to the CDM Executive Board for revision of the methodology for HFC-23 destruction numbered AM0001 in the CDM's methodology list. Although already phased out in the Organisation for Economic Cooperation and Development (OECD) member-states, according to the methodology 'waste HFC-23 is typically released into the atmosphere. Thus any HFC-23 not recovered for sale and not destroyed to meet regulatory requirements is assumed to be released to the atmosphere'.[16] This Swiss NGO's submission argued that HFCs would be phased out under the recent changes to the Montreal Protocol so, therefore, the methodology was redundant.

The Noe21 intervention has been one of many criticisms of the inclusion of the HFC-23 methodology in the CDM project cycle. Michael Wara (2007) points out that 'HFC-23 emitters [earned] almost twice as much from CDM credits as they can from selling refrigerant gases', as with their primary manufactured use. With these returns the 'CDM should also be understood as a very inefficient subsidy'. Various studies have found that the CDM could even have accelerated the production of these gases to maximize the credits generated through capturing them (Schneider et al., 2005; Michaelowa, 2009; Reyes and Gilbertson, 2009: 55). Wara (2007) calculated that implementing a technological solution would 'cost the developed world less than €100 million, saving an estimated €4.6 billion in CDM credits'. Furthermore, the EU Climate Policy

Directorate concedes that HFC-23 credits are an uneconomical method of greenhouse-gas mitigation (Duggan, 2011).

Against proposals to regulate HFC-23 using a standards-based approach, one Chinese official recently threatened that, 'If there's no trading of [HFC-23] credits, they'll stop incinerating the gases' and vent them directly into the atmosphere (LaBudde and Perry, 2011). However, questions over their validity, as well as their worth, have led many European states to discount or disqualify many existing HFC-23 credits. One analyst predicted the market for CERs falling into two tiers, with 'low-quality' offsets dropping to about 7 euros versus 11 euros for those not affected by any EU discount: preferred technologies such as wind (Carr, 2010). Proposals have proliferated as prices continue to flounder following the global financial crisis.

Supercritical coal

A recent report by the World Resources Institute (WRI) found that less than 30 per cent of the World Bank's lending to the energy sector has integrated climate considerations into project decision-making over the past three years (Nakhooda, 2008). As late as 2007, more than 50 per cent of the World Bank's US$1.8bn energy-sector portfolio did not include climate-change considerations at all. This has implications for not only the effectiveness of CDM governance, which will be dwarfed by these larger flows of public and private finance, but also puts into perspective the task of changing project development considerations (cf. Newell, 2009). However, even when climate considerations are included in World Bank decision-making, critics have argued that the assessment of methodologies against abstract emissions reductions has created 'a perversely circular structure where, instead of envisaging a rapid transition to clean energy, the CDM is subsidising the lock-in of fossil fuel dependence through providing incentives for new coal-fired power stations in the South, rather than renewable energy infrastructure based on local needs' (Reyes and Gilbertson, 2009: 57).

Like emissions trading schemes described in Chapters 2 and 3, the incentive structure of the CDM has enlarged the scope of the politics of energy production. The inclusion of supercritical coal projects in the CDM is analogous to the inclusion of Hazelwood in the NSW GGAS – both projects were rewarded with credits for plant upgrades that were planned or already underway.[17] The most notable and controversial coal project set to create CERs is the Tata Mundra project, a complex of coal-fired power plants in Gujarat, India. According to the World Coal Institute, 'supercritical steam cycle technology has been used for decades

and is becoming the system of choice for new commercial coal-fired plants' (WCI, 2010). However, with the support of the International Finance Corporation, the private investment arm of the World Bank, 3.6 million CERs are sought, generating an estimated US$50m per year (Reyes and Gilbertson, 2009: 57). Yet the scheme as a whole is expected to emit 700 million tonnes of CO_2 during its operating life, which is greater than one year's greenhouse gas emissions for the whole of the UK (Reyes and Gilbertson, 2009: 57). Axel Michaelowa's consultancy company, Perspectives, developed the methodology used for the project.[18] Thirty projects have been submitted as of 2015, with only one having credits issued so far (Fennhan, 2015). The CDM executive board limited its use to 15 per cent of power generation within any given country as a condition of its inclusion as a methodology.[19] Other power sources that applied for CDM funding include all 24 new combined cycle gas turbine plants under construction in China between 2005 and 2010 (Reyes and Gilbertson, 2009: 57).[20] These credits will nevertheless increase total emissions.

Hydroelectricity and wind

Hydroelectric project developers have provided creative responses to the demands of satisfying the 'barrier analysis' component of the additionality assessment. Dam development has been a crucible of Indian modernization (Marres, 2005; Newell et al., 2009; Benecke et al., 2007). Some have argued that it represents an indication of the relative influence of different actors over the project cycle. International Rivers, a lobby group based in California, has attempted to block the financing of dams through official submissions on specific projects. Reflecting on the success of this engagement, head of International Rivers Patrick McCully laments that 'we, and others who have submitted comments, have seen many of our submissions rejected or just ignored. Only the most minor of the comments we have made – for example, when we have pointed out small inconsistencies in data within PDDs – have been clearly acted upon' (Pottinger, 2008: 11). The ambiguity of the additionality assessment process has also been exploited by project developers in other ways. Schneider (2007) cites the case of the Patikari Hydro Electric Power Project in India, which responded to the barrier analysis by citing 'difficult terrain' as a challenge to project construction.

> The validation report notes that the validator asked the developer to 'provide documentary evidence that these investment barriers

> are particular to this project activity and not general risks associated with all hydro projects in mountainous regions'. The developer provided a geotechnical report depicting the poor nature of the terrain that might result in the caving in of the tunnel. This report was accepted by the validator as evidence of the existence of this barrier. (Schneider, 2007)

According to Schneider's assessment, the risk of tunnel collapse could be important enough to prevent the developer from going forward with the project 'without-CER' returns, or this risk did not affect the final decision. What is important in Schneider's understanding is that the validator does not seek to answer that question, because no evidence could be provided to support any answer – despite the formal necessity in the barrier analysis to be accurate (Schneider, 2007).

Barrier analysis has also required that the Executive Board pass judgements about the effect of policy decisions on project development. Wind and other renewable energy projects are typically the subject of national feed-in tariffs and a range of other initiatives. Therefore, domestic policymakers must calculate the effect of decisions about a change in tariffs on the financial viability of project development. Concerns about decreasing tariffs in China in 2009 led to the rejection of ten projects by the Executive Board just before COP15. In a question-and-answer session at COP15, board chair Lex de Jonge argued that the level of subsidies remained unclear and that only 'qualitative answers' were received about the reasons for tariff reductions. In other words, no subsidy rates were provided when Chinese authorities were queried by the UN. The board conducted an internal assessment indicating that 40 per cent of the tariff reductions were due to technological improvements that lowered the cost of turbine production. However, without detailed responses to the reduction in feed-in tariffs they could not determine the additionality of the projects and rejected them.

The presence of such uncertainties has meant International Rivers have also lobbied EU countries, discouraging them from purchasing credits from large hydro projects with dubious additionality, social or sustainability issues. They have enjoyed a moderate degree of success, with the governments of Germany, the Netherlands, and Flanders in Belgium having committedto only buying credits from large hydros which comply with the World Commission on Dams, a 'multi-stakeholder initiative developed by the World Bank and the World Conservation Union (IUCN) in response to growing opposition to large dam projects'.[21]

Legitimating CERs: from civic environmentalism to civilizing markets?

Attempts by 'economists in the wild' to establish the factual status of offsets has resulted in an increasingly complex, lengthy project-development cycle. Techniques of quantification and politics of market design are interdependent. The list of tricks used to outwit the executive board and its subsidiary branches is as long as the list of 'barriers' project developers must satisfy. This 'cat-and-mouse' game has seen board minutes backdated, fake transactions created between companies in the same group, dual loan application analyses showing both financial viability and non-viability submitted to banks (Haya, 2009), plant load factors – a measure of the average use of power – selectively under-reported to benefit additionality assessments (Michaelowa and Purohit, 2007) and the cutting-and-pasting of local stakeholder consultation records (see below) between project development documents (Lohmann, 2006). The circulation of such information is met with new hedging strategies to guard against the risks that projects would fail requests for issuance. Competition in the market for verifiers means that few projects are ever rejected; however, a re-estimation of credits initially validated can disrupt the market substantially. In 2007, after a series of projects had their credit levels re-estimated, Dublin-based EcoSecurities was forced to write down its total portfolio by some 40 million credits, causing the company's stock to plunge (Schapiro, 2010). The 2008 annual World Bank carbon report highlighted these emergent problems in the trust relations that underpinned the liquidity of the market:

> The secondary market for guaranteed CERs (gCERs) grew exponentially in 2007 to an estimated 240 $MtCO_2e$ worth about US$5.5 billion (€4.0 billion). This segment of the market, is, in effect, "derived" from the underlying primary market; and volumes transacted record the sale and resale of contracts in this financial market. Doubts about timely delivery of issued CER volumes have widened spreads [between the prices of 'secured' and unsecured primary CERs] by boosting demand and liquidity for exchange-traded contracts of the gCER as buyers seek compliance security. (Capoor and Ambrosi, 2008: 28)

Although this price spread reflects broader concerns about the status of the international negotiations about a second commitment period to the Kyoto Protocol, the question for policymakers remains what the CDM

will evolve into, rather than whether it will continue. The EU continues to pursue sectoral crediting mechanisms (Duggan, 2011). A number of proposals have been considered for crediting the emissions reductions from a particular industrial region and sector, such as cement or steel manufacturing. Under the sectoral CDM, a baseline is established for a whole sector, and emission reductions below the baseline are credited. Sectoral baselines could be established as intensity baselines (tCO_2 per output) or in absolute terms. In most cases, it has been suggested that the government receives the credits and provides incentives or regulations for the private sector to achieve the emission reductions. One advantage of such a proposal is that it renders decisions about baselines more explicit than a baseline-and-credit scheme with broader coverage, such as NSW GGAS where all reductions are commonly expressed as a headline figure.

Numerous proposals have been floated for enhancing the plausibility of emission reductions, including a UN take-over of the for-profit validators (who have responded – thus far successfully – with fierce lobbying of the executive board). Validators would then be randomly assigned to assess projects, disentangling project developers from building tacit social relations with their validators (Schapiro, 2010).

An emergent response to the emphasis on the factual status of project outputs has been that it suffocated discussion of its 'input' legitimacy (Lövbrand et al., 2007). This is important because economists' counterfactual metrics of investment attractiveness presume a standard of governance in host countries. The output legitimacy of projects requires projects to satisfy (a) additionality (Would the project have proceeded without finance or is it more efficient than an agreed baseline?), and (b) verification (Did the project developers actually do what they promised?). Input legitimacy, on the other hand, is a function of consent and accessibility. Input legitimacy refers to the ability of stakeholders to resist projects that they will be affected by. The concept of 'input' legitimacy is therefore analogous to notions of 'negative liberty' in media and political theory (e.g., Jones, 2007). A number of studies have identified problems with a 'stakeholder consultation' embodied in the PDD consultation phase in addition to the Patikari Hydro Electric example discussed above. Project developers are required not only to consult representatives of the population (e.g., the host country government) but also make explicit references that 'individuals, groups or communities' that are likely to be affected by the project have been consulted.

Lövbrand et al. argue that this aspect of the CDM represents an excellent test case for the strengths and potential pitfalls of 'civic environmentalism', which promotes the democratic imperative that the securing

of all social actors affected by a project should be able to influence the project design through an open and transparent decision process (cf. Dryzek, 2006). Drawing on three CDM projects as case studies, Lövbrand et al. argue that consultation often takes place late in the planning process when most decisions have already been taken, and that it does not guarantee any real influence over decisions (Lövbrand et al., 2007). These anecdotal findings are supported by a review of the consultations described in PDDs submitted to the CDM Executive Board (and made publicly available on the UNFCCC website). Schneider found that over a third of projects did not even inform, let alone engage in dialogue with, 'affected individuals or communities'. The remainder were the subject of 'announcements in different media or by similar methods, such as loudspeakers, [which] are the most common practice and were made in 39 per cent of the projects. In 25 per cent of the projects, no public announcement was made' (Schneider, 2007: 51–53). Longstanding calls by observer organizations for the creation of an appeals procedure to secure the rights of local stakeholders, investors and governments (Paulsson, 2009; Streck, 2007) were finally heeded during the negotiations of COP15.

While the CDM offers several entry points for stakeholders to provide input to the process, question projects and potentially seek redress, it seems as though the CDM provisions for information access are still too vague to be an effective instrument for participation and accountability (Lövbrand et al., 2007). With a few notable exceptions,[22] NGOs have seldom engaged with formal avenues to challenge CDM projects during the consultation phase (Paulsson, 2009). Lohmann (2006: 194) cites frustration with the formatting of the design documents themselves: 'an Indian social activist remarked on being confronted with an official UN form for submitting comments on a CDM project, "the form for public input is so full of technicalities there seems to be no space for general comments"'. Furthermore, Lohmann argues that the very structure of consultation is 'unfriendly to democratic discussion of social goals':

> [A]nyone wanting to comment on planning documents for CDM projects (for example) has to learn English, find a computer, log onto a website, register, and then navigate hundreds of pages of technical jargon, usually under a tight deadline. CDM comment forms provide no spaces for discussing the reliability of the implementing companies or the indeterminacy and scientific ignorance that stand in the way of the projects' being verifiably climatically effective. Nor are

> there spaces for questioning the ubiquitous assumption that such projects produce 'emissions reductions'. (Lohmann, 2006: 194)

The limits of considering 'input legitimacy' by extending rights to 'all affected' become quickly apparent in these cases: 'Stakeholders' require not just the means of raising objections, but the capacity to evaluate complex calculations such as grid emissions factors and to articulate their objections for them to be raised in the formal decision-making process of the executive board. Dialogue about projects requires expertise and calculative capacity beyond that of most actors affected by a project. This endemic asymmetry goes beyond what in theoretical literature is termed an 'information asymmetry' (Fischer, 2005) where information processing is a capacity of human agents. Instead, it points to the technopolitics of carbon offsets insofar as there is a need for devices to mediate and communicate relevant data to those affected.

Clean Development as governing beyond the state?

Building processes, procedures and institutions to establish input legitimacy devolves decision-making onto project developers, shifting emphasis away from the host state. The implication here is that, rather than presuming functioning governments in host countries speak for the governed, project developers must take responsibility for the social impact of their projects.

One means of addressing this need for interaction is through what Callon (2008a) terms 'habilitation policies'. Habilitation policies modify a network to ensure all participants have the equal capacity to assess things. For example, mandating Braille on automatic teller machines ensures that blind customers do not need to use a bank. Callon contrasts these with 'prosthetic policies' – material devices such as guide dogs or hearing aids that endow participants in a network with capacities to participate as well as others. Habilitation policies for the CDM could involve improving the requirements of community consultation to fit with the local needs.

This idea could be extended to project development too. The financial and technical barriers to developing large-scale projects have meant that only a small group of project developers have been able to cope with the regulatory uncertainties that have accompanied them. The framing of carbon offsets through the institutions of the CDM and national caps on emissions has led to alternative markets being developed in emissions reduction credits. These markets have their precedents in the dissatisfaction with the decision to allow the Clean Development Mechanism

credits to include those derived from HFC-23 destruction. In fact, this decision fostered the development of the competing Gold Standard (MacKenzie, 2009b).

The market for CDM credits also includes a simplified project cycle for the development of 'small scale' projects with a capacity of 15MW or smaller (Boyd et al., 2007). This is intended to satisfy the demands many NGOs have placed on the need for small-scale projects, though this specification has been criticized for actually constituting a barrier to community-based projects that may require a much smaller capacity (a few hundred kilowatts) (Filamozer, 2009). The 15MW specification has meant that the small-scale sector is dominated by for-profit developers, who are the only ones able to satisfy the demands of project development. The German organization CDM Watch has argued that the dominance of large industrial credits has marginalized the local poor and has seen little wealth trickle down (Filamozer, 2009). Rather, site visits by CDM Watch to the flood of small-scale projects that have entered the CDM pipeline in recent years revealed small-scale hydro projects that had damaged and displaced villages without compensation (Filamozer, 2009). Initial assessments of the uptake of small-scale forestry projects suggest similar problems, with little development of projects proceeding from the 'bottom up' (Boyd et al., 2007).

Conclusion: confronting the politics of offsets

International carbon-offset rules and methodologies have not been the site of the kind of international learning and critical reflection expressed in Callon's (2009) ideal of collective experimentation. Data were not gathered from the Pilot Phase through the transparent reporting of project outcomes to achieve the status of fact for collective reflection on experimental processes. Rather, the advance of international carbon offsets as a mitigation solution was a product of negotiation requiring considerable interpretative flexibility to accommodate competing demands and incommensurable frameworks of evaluation. This flexibility was exploited and distorted by decisions about a handful of projects responsible for the largest number of credits, such as HFC-23, which have tended to be downplayed in official reports, such as the 2013 CDM executive board report (United Nations, 2013). The competing rationales of low-cost, environmental integrity and national development are likely to see further calls for reform. Carbon offsets have overflowed and will continue to overflow, as they are justified according to

one or another competing rationale – just as the 'Gold Standard' directly contested cost in favour of environmental integrity.

The development of flexible mechanisms has placed economists like Axel Michaelowa in positions of authority, offering the illusion of objectivity in a negotiating context where demands to rise above politics appeared irresistible. However, attempts by economists to 'sever the Gordian Knot' between economics and politics robbed carbon offsets of their capacity to be evaluated beyond narrow economic terms and, instead, created a powerful new class of bureaucratic experts. The objectivity of price did not replace the work of civil and bureaucratic decision-making and expertise. National bureaucracies have still been required to certify credits according to each country's determination of sustainable development criteria. Far from substituting expertise with prices as per neo-liberal objectives, offset projects have had to align with nation states' objectives because states ultimately provide the legitimacy necessary for carbon markets to function. Multiple orders of evaluation, beyond the simple cost-effectiveness of carbon offsets are required to ensure projects satisfy host and financier countries. Rather than governing 'beyond the state', carbon markets have required new rules, laws and regulations to certify financial flows according to the economic development imperatives of nation states.

A politics confronting the tensions between measurement and counterfactual judgements at the heart of carbon offsets must justify projects for their contribution to the civilizing of markets by ensuring matters of concern are effectively addressed. The challenge of addressing these concerns adequately should not be understated. It is questionable whether carbon offsets have provided a more streamlined and cost-effective mitigation strategy than standards-based or other direct approaches, as US proponents of flexible mechanisms had hoped. Furthermore, the cat-and-mouse game between CDM regulators and project developers has created information barriers in rule-making that have crippled the scheme. With such endemic uncertainty, the ability to calculate the future is unevenly distributed to a much greater extent than the original proponents of emissions trading could have ever dreamed. Those lacking the capital to wait out or risk potential delays or interruptions to their projects have been shut out of the market as project administration costs have mounted.

6
The Paradox of Measurable Counterfactuals and the Fall of Emissions Trading

'The paradox of measurable counterfactuals'

> What we want to stress is the epistemological ambivalence and the contradictions of neo-liberalism – the ways that the fallibility of expert knowledge are alternately highlighted and downplayed – are marshalled as a vital defence mechanism against unwanted governmental intervention. (Davies and McGoey, 2012: 73)
>
> If we remain stuck in the short time frame of the now we are also likely to become bereft in the imagination of futures. (Back and Puwar, 2012: 8)

Counterfactuals are speculations about the future; literally thought experiments in possibility. At base they are 'if X then Y statements'. In this sense, they are essential inputs to and outputs from economic modelling: potential futures must be speculated upon to make them calculable. Modellers themselves are all too aware of the limits of their tools; however, these tools must be understood by policymakers who have their own agendas and rationales (MacKenzie, 1983). The paradox of measurable counterfactuals lies in the ambivalent epistemology of emissions reductions against some imagined 'command-and-control' future. At base, the paradox is:

> The emissions reductions are objective and therefore beyond politics.… We agreed on how to measure the Baseline against which emissions are to be reduced.

This paradox is most readily visible in evaluations of emissions trading – the claim that pollution has been 'saved' through some initiative or another rather than business-as-usual efficiency improvements through the kinds of technological progress characteristic of industrial capitalism. In the preceding chapters, I have shown the ways in which measurements of pollution are always already bound up in the political, social and juridical. Pollution measurement and trading of CO_2 equivalence are not external benchmarks to society but modifications at the margins of industrial capitalism that has arisen in a specific historical, disciplinary, technical, economic and organizational context. 'Business as usual' *is* the creation of new forms of expertise to conquer the boundaries of industrial expansion and the erection of new legal regimes to minimize disruptions to trade.

This chapter outlines how the inability to civilize markets in Callon's terms represents a fall in emissions trading's place in the hierarchy of policy. Carbon pricing will remain an important regulatory mechanism, but the dream of a global and seamless network of efficient carbon-pricing signals – a network that animates the World Bank – is misplaced and counterproductive. Despite carbon pricing changing the 'bottom line' of capitalism in the EU ETS (MacKenzie, 2009a), there remains a panoply of laws protecting the property rights of companied that are highly greenhouse-gas intensive, companies for which greenhouse gas regulations have failed to gain traction. The treaty on the International Sale of Goods and many key international free-trade agreements measure economic effects that do not include carbon emission calculations at all. The international trade regime has, since the 1970s, been imagined as an *agencement* designed to evaluate economic effects upon gross domestic product, rather than consider economic forms (Lang, 2011). The insulation of international trade from both consideration of form and wider environmental effects suggests that carbon-pricing institutions have amounted to much less than the sum of their parts.

Debates over climate-change mitigation policy have been one-way critics of neo-liberalism have challenged such hollow measures. Quantification, numbers and modelling have attempted – unsuccessfully – to supplant judgements and ethics in liberal governance. This creates tension between the rhetoric of objectivity on one hand and practices of negotiation and numerical production on the other. Numbers can constitute the domains they appear to represent; they render them representable in a docile form (Rose, 1993). This docility is often an attempt to 'cool' or depoliticize complicated decisions, particularly where experts are mistrusted and need to justify their judgements

as disinterested, objective or transparent. By transforming lightbulb replacements, HCFC gas outputs and satellite data of trees and shrubs into abstruse calculations about past, present and future tons of carbon, various actors seek to control such diverse sites as farms and forests, air-conditioning manufacture and electricity markets. In this sense, the paradox of measurable counterfactuals expresses the 'performative' dimension of carbon markets: the ways a (hitherto recalcitrant) economic actor – *homo carbonomicus* (Blok, 2011) – has been brought into being through the many devices of regulation.

The paradox of measurable counterfactuals builds on the concept of 'advanced liberal democracy' (Rose, 1993) in two main ways. The first has to do with the elaboration of governmentality and the development of insights from material sociology to evaluate the neo-liberal claim that bureaucratic expertise was *measurably* worse than market-like alternatives. Chapter 4 examined the ways instrumental outputs can be understood according to a range of social and political preferences (hence the 'interpretive flexibility' of carbon accounts). Furthermore, neo-liberal claims of efficiency through individual bargaining were contested by examining the materiality and calculative power of incumbent players in forestry and in electricity production: the ways emissions trading regulations require arcane baseline data possessed by incumbents and their allies. The observation that incumbent players hold advantages through their capacity to reorganize resources and skills around new calculations associated with emissions reductions is common to a variety of economic schools of thought from Marxism to neoclassical economics. The material sociology approach taken as the point of departure for this book, however, has instead shown *how* action is distributed and constrained on carbon-offset production and trading behaviour. Each industry and domain of carbon reduction has different constraints upon calculation that must be understood empirically in terms of social, legal, cultural, technical and economic form. Attempting to affect carbon reductions through abstractions of economic rationality has proven ineffective when these other factors have been ignored.

Furthermore, this focus upon economic rationality through effects alone informs a linear narrative of carbon marketization as a policy innovation, leading to the 'ambition paradox' outlined below. This narrative (exemplified by Garnaut above and American commentators such as Stavins) circumscribes the historical relationship between regulation and neo-liberal economics, neglecting the broader role of science. Neo-liberal theories can be understood as facilitators of particular governmental actions through expert judgements about their economic

'efficiency', rather than the rolling back or restraint of government through individual freedom, as proclaimed by proponents.

Economic efficiency is not the only measurement in the assessment of carbon markets, even if it predominates. Empirically, measurements of the 'additionality' of carbon offsets have been enormously consequential but difficult. What on the surface appears to be an economically efficient transfer of money through carbon offsets may be a gross waste of money. Even ardent supporters of emissions trading agree that additionality is 'complex, requires extensive review and monitoring by third parties or regulatory agencies, and risks undermining the objective of a policy' (Aldy and Stavins, 2012: 160). For example, using China's prefecture-level economic and emission data, one study found that up to 75 per cent of overall projects, including some 55 per cent of wind power projects were probably not additional (Zhang and Wang, 2011).

The paradox of measurable counterfactuals means that there is no definitive measure of efficiency because claims to expertise are always already undermined. Price theory is always operated from shifting sands. The paradoxes that govern contemporary carbon markets ensure that *different* baselines and *different* units of 'CO_2-reduced' will be arrived at in different jurisdictions according to prevailing juridical and political circumstances.

'The collective calculation paradox': self-loathing experts at the heart of contemporary liberal government

Earlier dreams of carbon pricing replacing 'centrally planned' taxation (exemplified by Garnaut above) have not panned out. The latest World Bank annual report is no longer entitled 'State of the Carbon Market', as it was from 2008–2013, but rather 'State and Trends in Carbon Pricing' in 2014. The authors of this report state:

> Blending of carbon taxation and emissions trading approaches is becoming more popular. Several jurisdictions are now experimenting with carbon pricing options that include elements of taxation, emissions trading schemes and offset crediting. In South Africa and Mexico, for example, taxes are combined with the offset credits. (World Bank and Ecofys, 2014: 18)

The blending of taxation and tradeable permits is not just a matter of messy policy, but signals what I term the collective calculation

paradox: the precarious – often contradictory – status of experts under neo-liberalism.

> The collective calculation paradox is that carbon markets are governed by self-loathing economic experts: their authority relies upon the public, centralised expertise necessary to set caps whilst also attacking this centralised expertise as unnecessary.

In this book I have discussed two manifestations of neo-liberalism: the Chicago school attack on the authority of public, centralized expertise, which wishes to thereby diminish regulation; and the Porter School of Competitiveness, which used a teleological argument for environmental regulations. Both of these schools rely parasitically upon the technical practices of measuring emissions that established the authority of civil scientists. Pollution-regulation agencies became accountable to new bourgeois publics, rather than being privately negotiated. However, the rise of quasi-private regulation through fines represents an undoing of this public, expert regulatory artifice (Nicholls, 2014). To recap: the achievement of civil scientific authority did not see the incursion of values and politics into an otherwise objective scientific sphere; rather, measuring pollution outputs was a value-laden activity which entangled industrial expansion with new forms of technical fixes and data publications. Ways of knowing and valuing are always entangled.

Chapter 2 staged this paradox at the tensions between environmental economics and civil science. The subsumption of the latter into the former suggests another way economics sought to add a 'protective layer' (Latour, 2014) against meddling by environmental concerns. Chapter 2 drew attention to the bureaucratic authority of Robert A. Smith and his staff as facilitators of the continued industrial expansion beyond the juridical limits of *laissez faire,* namely torts. For almost a century succeeding Smith's work, civil scientists established new 'frames' to reincorporate the 'overflows' of industrial expansion by certifying and standardizing pollution outputs for liberal nation states. This dynamic of framing and overflowing does not mean that the work of civil scientists was reducible to economic concepts of 'efficiency', as it is read by neoclassical economic historians, but rather that the work of civil experts was necessary for delineating national economies as measurable units. Only through the *moral* work of civil science has economics been able to represent and intervene in the economy through tests, models and measures such as market equilibrium and utility maximization now used to govern neo-liberal trade regulation.

Chicago school neo-liberals, and their acolytes in environmental economics, erected tests of regulatory efficiency as 'protective layers' to their economic authority, challenging both the authority of civil experts to represent the effects of pollution and the objectivity of their regulatory prescriptions to restore pollution output to socially acceptable limits. A key strategy for neo-liberals was to characterize civil expertise as intrusive and meddling, thereby obscuring the facilitative nature of this expertise and its accountability to industrialists, elected officials and enquiring publics. The pejorative term 'command-and-control' effectively conflated civil expert advocacy of pollution standards with images of Soviet production quotas, helping to identify market-like pollution regulation as a governmental concept to restrain civil expert claims to intervene in economic activity for fear that such interventions may diminish aggregate economic welfare.

In Chapters 1, 2 and 3, I situated the emergence of emissions trading in these concerns about rising bureaucratic power immediately after the Second World War. Neo-liberals such as Coase established the formal foundations of emissions trading in direct competition with civil scientific claims to economic authority on the basis that civil experts could not know the 'true' cost of externalities such as pollution.

The paradox of collective calculation expresses an historical irony: Coase's critique of taxation came almost a century after the limits of torts were overcome by civil science. 'Transaction costs' are legal, sociomaterial and historical achievements, rather than simply a reflection of the cost-minimizing rationality of economic actors who operated within the cognitive parameters stipulated by economists. As seen in Chapter 2, neither science nor individual valuation (as in Coase's critique of taxation) of pollution revealed its 'true' cost. Rather, the cost reflected multiple interventions by government and civil actors. The material specificity of the inscriptions of acidic pollution, especially acid rain, was highly consequential to the form of the sulphur permit trading scheme and the assessment of its performance. Chapter 2 described the lengthy, careful and complex undertaking by civil scientists, such as Eville Gorham, to develop techniques to authoritatively represent the nature of acidic pollution and its spatial boundaries as well as address the causal relations between source and receptor. Once questions of causation were addressed, the possibility of 'efficiently' dealing with its scope through the commodification and marketization of pollution could be canvassed. The extent to which the pollution was valued or known as an 'externality' to be 'internalized' within regulations was the *outcome* of collective negotiation including civil society. If the collective

calculation paradox arises from an over-reach of neo-liberalism into politics, that can only be addressed by starting analysis from issues as collective phenomena (Rogers and Marres, 2000; Blok, 2011).

'The ambition paradox'

A corollary of the collective calculation paradox is the ambition paradox:

> Public pressure on governments and corporations – 'ambition' – is needed to drive demand for carbon offsets and prevent global warning.... Corporations and regulators will not respond to public pressure but will instead negotiate the enforcement of regulation privately.

At the heart of the ambition paradox lies a conflation of the political and socio-economic successes of the US sulphur dioxide trading scheme. Environmental economists built careers on establishing a powerful historical narrative about the sulphur permit scheme, one which continues to inform policy debates in advanced liberal democracies (e.g., Zwaniecki, 2009). According to this narrative, using the flexible emissions trading approach over traditional regulations created incentives which stimulated innovation and led to 'gains from trade' (Carlson et al., 2000).

The significance of the narrative is not just this message of market superiority, but its starting point *in economics*. All three critical histories of emissions trading theory and experimentation discussed in Chapter 1 start from Coase's and Dales's theoretical work and progress to small experiments with 'bubble' and localized trading schemes, such as the US sulphur trading scheme, and then immediately proceed to the EU Emission Trading Scheme (MacKenzie, 2009a; Voss and Simons, 2014). In MacKenzie's analysis, this linear narrative is a reflection of economists 'performing' neo-liberal theory, rather than an unfolding rationality. For Voss (2007), however, the linear narrative is more explicit – theory, testing, proof of principle, acceptance. For Coase, each phase of emissions trading – from theory through to sulphur permit trading and then carbon emissions trading – is built on the earlier phase in a linear fashion.

However, all these critical histories obscure the historical relationship between neo-liberal narratives and civil expertise. They all take their points of departure in Coase's concepts of 'social cost', rather than assessing how his method developed as a critique of civil expertise. As

argued in Chapter 2, however, trading did not substantially modify coal-fired power station technologies. Other neo-liberal programmes, especially the deregulation of freight rail, contributed to reducing costs of compliance with quantitative emissions reductions. Economists authoritatively spoke for the measured emissions reductions, therefore reinforcing the idea that such reductions could be quantified, commoditized and traded in the future.

The subsidiary role of scientific assessments of pollution damage in the sulphur permit trading scheme draws attention to the premier role of economic expertise in promoting 'efficient' carbon offsets. the preceding chapters have interrogated the ways economic concepts – rather than science dictating an authoritative 'cap' on pollution – were combined with techno-scientific and other measures to create abstract quantitative emissions reductions. In the case of the NSW GGAS, offset rules were negotiated in ways that insulated incumbent energy-supply industries from making substantial changes to their practices. Although the outcomes were public, the process was a quasi-private negotiation whereby private law firms advised governments on the drafting of the legislation before advertising their services to liable parties. The accountability of regulators to industry is entirely characteristic of industrial capitalism, as I argued in Chapter 2. However, what is new under neo-liberalism is the increasing privatization of regulation through arbitration whereby public engagement is only through media release of negotiated outcomes (Nicholls, 2014). Here, economic efficiency enters again as a calculation of the cost of litigation offset by negotiating fines with regulators.

The indebtedness of neo-liberal theories to earlier economic theories further emphasizes the poverty of linear narratives of the development of emissions trading schemes. This is because they ignore the historical relationship between economics and civil science. Linear narratives view the construction of carbon markets as the logical and rational means to pursue economic growth; however, the many failures of emissions trading schemes to effectively secure putative emissions reductions are obscured by such a narrative. The NSW GGAS and AIJ pilots discussed in Chapters 3 and 5 underscore the problematic relationship between claims of economic efficiency, effective institutional learning and plausibly increasing emissions reductions that correspond with bringing greenhouse gas concentrations down to prevent 2 degrees of warming.

'Civilizing markets'?

Another strategy for contesting rationalist accounts of carbon markets has been to examine the ways economic theories were performative, in

the sense that they were institutionalized as market-like mechanisms. The implication of Callon's (2009) appropriation of this idea (explored in Chapter 1) is that carbon markets can be more democratically 'performed' by introducing appropriate rules, procedures and institutions to accommodate 'matters of concern'. These matters arise when any agreement is made that frames a settlement between economic and scientific affairs. Callon promotes a 'dialogic democracy' whereby the input and participation of expert and lay actors are given equal weight in assessing how to resolve techno-scientific dilemmas such as those climate policy seeks to address (Callon, 2009; Callon et al., 2009). This model of 'dialogic democracy' has the virtue of bringing the social and technical elements of politics together. Rather than modelling 'community' upon purely social bonds independently of the material world of techno-science, the model of 'dialogic democracy' draws attention to the ways issues concerning technology generate new social groups that are then able to forge a place in the body politic. The concept of 'civilizing markets' aims to bring diverse, affected social groups into the design, observation and reflection upon and regulation of carbon markets. Callon's vision of a 'civilized' market is one in which international reflection and collaboration are anchored in civil science and society:

> NGOs become legitimate and unavoidable partners, and the emergent concerned groups who demand, through spokespersons, to be heard and taken into consideration, can no longer be completely ignored. The way of organizing the international public sphere and of making visible problems qualified as political, changes as the organization of markets evolves. Science ends up being transformed and redefined: first, in its content, for models explicitly combine economic with climatologic and geophysical variables, and there is no reason for this interdisciplinary integration to stop; and second, in its organization, with the constitution of a world parliament of specialists (the IPCC) who, like any political assembly, negotiate the content of their reports among themselves and vote on scientific facts before making them public and passing them on to policymakers. (Callon, 2009: 544)

However, the cases discussed in this book suggest two problems with Callon's vision of civility. Firstly, his model of dialogic democracy appears to assume too much of lay actors' goals, knowledge and resources in relation to carbon offsets. Callon's model appears similar to analytic-deliberative models that involve extending the epistemic agent

of economic models to the wider population. These agents are epistemic in the sense of knowing about the nature and scope of issues concerning carbon markets. This population is assumed to have the will and capacity to articulate issues that can then be rationally transformed from being matters of concern into a form of dialogue for addressing that concern. However, this book has shown how a commitment to the imposition of neo-liberal economic theories on carbon offset markets has stifled the capacity of actors to deliberate over the shortcomings, goals and objectives of climate policies. The *boundless possibilities*, coupled with a *total indifference* that Latour (2014) flagged as a general affective response to capitalism, operates where carbon markets are concerned too.

The considerations of 'transparency' alluded to above draw attention to a second and related issue with his idea that the techno-scientific dimensions of climate policies can be reorganized. As I argued in Chapter 4, however, the international architecture of climate negotiations is built upon a specific, instrumental arrangement of science, economics and politics. What mutually constructs and reinforces one another are 'the intellectual order of climate scientific prediction, and the *political* order of global management and universal policy control based ... on the promise of deterministic processes, smooth changes, long-term prediction, and scientific control' (Shackley and Wynne, 1996: 371).

The difficulty of challenging this vision of control with ideals of civility is that many of the *agencements* of carbon markets have been made with scant regard to democratic deliberation. The influence of NSW State Forestry on the rules for tree plantation carbon offsets, as I have shown, offers a case in point. Plantation offsets were closed to reflection about the goals because of the 100-year permanence rules ingrained in the Kyoto Protocol *agencement* described in Chapters 3 and 4. Here, the management of carbon sinks required references to land-use change be circulated only amongst a politically selected group of experts. The design of 'carbon pools' was situated in regimes of practices that had evolved over time from which the framing of carbon offsets was derived. Making carbon offsets is thus a political matter as much as a technical one.

A second and related problem with Callon's proposal is his suggestion that the logic of maximizing 'gains from trade' – the ostensible policy rationale for emissions trading – can be disentangled from the ways local actors exploit their calculative power in market design, construction and operation. As discussed in Chapter 1, Callon assumes that the '*in vitro*' work of 'caged economists' and *'in vivo'* markets, shaped when these economists step out in the political 'wild', can

and should be linked effectively (Callon, 2007b; Callon and Muniesa, 2007). However, this book has shown a repeated discrepancy between 'caged economists', who formally design schemes in the comfort of their offices according to theoretical imperatives, and the capacity of 'economics in the wild' to make scheme designs work. It is only by abandoning the linear, abstract notion of market innovation and its attendant assumptions of market equilibrium that the sub-political nature of scheme design could align with the civilizing goals imagined by Callon. In other words, it would require a carbon market that has not been invented yet.

Whither carbon markets? The 'death' of the EU ETS

> [The EU ETS is] failing due to a lack of demand and a lack of any sign that there's going to be any demand in the future. http://www.bloomberg.com/news/2014–03–11/emissions-pioneer-losing-clout-as-eu-ban-looms-carbon-climate.html
>
> The backloading process has failed to adequately address this surplus and its depressing effect on price. Multinational investment analysis house UBS slashed its EU ETS price forecast, says backloading had muted effect so far. http://twitter.com/MichaelSzaboCO2/status/468691094994042880

The fate of the EU ETS, a key inspiration for Callon's vision of 'civilizing markets', provides object lessons in the inertia and rigidity of contemporary economic government. The cumbersome, rigid, labyrinthine character of contemporary carbon markets is of relevance to a broader point about the limits of quantification evident in the supposed 'death of the EU ETS', as one participant in that market recently proclaimed (Chaffin, 2012). The problem of 'civilizing markets' is an issue that has risen to even greater prominence since the publication of Callon's (2009) paper. This prominence is true of both the EU Emission Trading Scheme, whose experimental phases inspired Callon, and the national economies the scheme is designed to transform. If emissions trading was, as Lohmann (2006) quips, 'born in the USA', its prolonged demise in Europe has much wider ramifications for the peculiar neo-liberal visions of economic efficiency from which Coase's ideas proved so fertile.

For political economists, such as Reyes, emissions trading schemes have always been 'at the mercy of a complex interaction of state and corporate power' (Reyes, 2011b). For Reyes, this has meant that 'those with the loudest voices have successfully pushed for rules that allow them to escape their responsibility to change industrial practices and

the means of power production domestically'. The 2014 World Bank report on carbon pricing echoes these sentiments, stating that 'the main reason for the lower prices currently seen in emissions trading schemes seems to be that taxes often exempt industry and put the tax burden on private households thereby avoiding issues of competitiveness and carbon leakage' (World Bank and Ecofys, 2014: 52). This reinforces the point that international trading competitiveness is overwhelmingly prioritized in policy to the detriment of environmental efficacy.

The wider economic forces of competitiveness seem to have effectively destroyed carbon markets in the near-term. The credit and fiscal crises of 2008–2009 in Europe hit the EU ETS, dampening economic demand and leaving a glut of allowances. This stifled demand for carbon-offset projects and sent prices down across the board (World Bank and Ecofys, 2014). Thus, in 2014 a proposal to 'backload' was constructed and passed through the EU Parliament to realign the policy ETS objectives with this changed reality. The 2014 World Bank report suggests

> the current market experience witnessed through the backloading negotiations does suggest that the carbon price responds to some degree to any news related to the topic. This response may indicate that current prices do, to a certain extent, reflect shorter-term priorities, and may reflect an expectation that these allowances might eventually be cancelled. (World Bank and Ecofys, 2014: 71)

Thus, the power of incumbent players may not be decisive in killing carbon markets directly, but rather that the regulations are so labyrinthine that they prevent any concerned group from making an effective impact because it would be too difficult to mobilize 'concern' over the abstract details of the scheme. Here, the ambition and collective calculation paradoxes are fully evident.

As for the credit crisis, MacKenzie (2009b: 179) has argued that it should be understood as a combination of both 'big' discursive, historical factors and 'little' technical details involving securities, especially collateralized debt obligations. The 'big' factors contributing to the credit crisis listed by MacKenzie encompass the glut of savings in countries such as China and neo-liberal ideas promoting deregulation. It was the failure of these ideas that led Alan Greenspan, the former chairman of the US Federal Reserve, to inform a Senate committee in 2008 that the 'entire intellectual edifice' on which his own monetary policies were based was now in ruins (quoted in Davies, 2012).The notion that economic actors are best left alone to make their own decisions and

pay for their own mistakes was at the core of this 'edifice'. It was also a central proposition for Coase's (1960) work that anchored economics in clearly defined property rights in order to insulate individuals from the vagaries of distant bureaucrats. Thus, the proposition that markets can effectively manage economic affairs *measurably* better than more coordinated civil approaches also requires revisiting. The importance of policy design further undermines the case that there are inherent advantages to using markets over civil regulatory approaches such as those at the heart of President Obama's use of section 111(d) of the Clean Air Act to regulate power-station emissions.

Though the crisis of the EU Emission Trading Scheme has been arguably more straightforward than the credit crisis, the possibilities of resolving it are certainly no less complicated. The EU allocated 2,135 million tonnes worth of allowances for Phase II of the scheme (2008–2012); however, verified annual emissions have consistently remained below this figure. From 2008–2010, 481 million tonnes were accumulated as a surplus. For the World Bank, the mechanism learned from experience that an inflexible, predefined supply of allowances does not address unforeseen macro-economic changes, while the demand adjusts itself. A form of 'reserve bank' would thereby 'both tackle current surplus and make future supply of allowances more flexible against changing economic conditions' (World Bank and Ecofys, 2014: 71). Here, economic expertise enters again to ensure the ethical and social objectives of avoiding dangerous climate change align with the pricing mechanism itself. This is a necessary, but insufficient step forward in climate policy.

Rules regarding AAUs will determine the extent to which compliance with the EU target of emissions reductions will be achieved within its borders or through international carbon offsets. Such rules are crucial to the success of emissions trading. In MacKenzie's (2009b) analysis, the 'mechanistic' National Allocation Plan formula to allocate allowances based upon each country's GDP served to restrain the tendency to over-allocate permits in Phase II of the EU ETS. The collapse in *demand* for permits, it could be argued, was an unforeseen consequence that should be assessed separately from these rules. European policymakers are clearly under pressure to demonstrate numerical reductions in emissions (Wyns, 2012b; Wyns, 2012a). These are also judgements about the technological form of energy infrastructure in their countries in the sense that adding rules for importing 'cheap' credits may extend the life of fossil fuel infrastructure financiers in the EU.

It is well beyond the scope of the present discussion to assess how rules might be developed to balance these needs for efficiency and

technological transformation; that is a political decision for Europeans and the citizens of the host countries of carbon offsets. However, it is worth stating that there is no sign of a retreat from the EU ETS to simpler direct regulation despite the failure of 'backloading'. Rather, proposals have focused on building a more elaborate trading scheme under the Effort Sharing Decision as part of the 2008 EU climate package. Proposals have focused on expanding trading to all sectors not covered by the EU ETS to complement the existing sectors covered (see, also, Duggan, 2011; Sanderson et al., 2008; Wyns, 2012a).

From civilizing markets to remaking value

The 2008–2009 credit crisis offers one way of understanding the proliferation of schemes and associated regulatory currencies (AAUs, EUAs, standardized baselines, CERs, etc.). In MacKenzie's (2011) analysis of 'credit default options', evaluation practices are not reducible to neoclassical economic measures, but are negotiated within organizations that value certain attributes of a derivative differently, according to incommensurable parameters of evaluation. The friction between these parameters, like the friction between the different social groups involved in CER production, is a source of innovation. By keeping multiple incommensurable frameworks of evaluation in play, developers of new derivatives can find an edge in the market or exploit discrepancies between their own framework and those representing market prices. These matters overlap with issues around the valuation frameworks discussed in Chapter 5 relating to the incommensurable justifications for carbon offset projects. Emissions trading proponents in the 1990s (the Pilot Phase) were able to justify carbon offsets according to their industrial, civic and economic worth.

However, in MacKenzie's analysis of derivatives, there was little of what David Stark has termed 'heterarchy' (Stark, 2009) in the negotiation of credit derivatives markets. Heterarchy refers to 'flexible governance that makes friction productive by facilitating organizationally distributed reflexive cognition, with, for example, elements of self-management and lateral accountability rather than simply vertical authority' (MacKenzie, 2011). MacKenzie observes:

> What is in retrospect striking is how little sense there was before the crisis of the dangers that were accumulating in CDOs [collateralized debt obligations]. Instead of [heterarchy,] what I have found is more often reminiscent of the rigidities and barriers to information flow in the back-ground of the Challenger disaster.… As noted in the

> introduction, the CDO [credit default options] seems less the productively polysemic 'boundary object' of the social studies of science (Star and Griesemer, 1989) than a kind of epistemic orphan, cognitively peripheral to its parent worlds, and not the object of a new creole or even much of a pidgin. (MacKenzie, 2011: 1831)

The cumbersome and rigid carbon markets studied in this book suggest that this conclusion equally applies to the currencies of NSW GGAS, the AAUs market presented in Chapter 4, and the market for CERs in Chapter 5. Instead of operating as a vehicle to civilize, *pace* Callon, carbon markets appear to share the worst pathologies of financial markets. This flaw is not a result of their 'lack of transparency' but rather because their rationalist assumptions lead to *agencements* too abstracted from the goal of transforming socio-material energy supply and consumption infrastructure. The point is therefore not to civilize markets but to remake the value of economic flows in a sustainable way.

This chapter has examined the paradoxes of emissions trading to emphasize that, above all, economic calculability is the historical and sociological achievement of civil science. Placing narrow measures of economic efficiency at the centre of law and policy only serves to undermine this achievement. To reinforce the argument of Chapter 2, civil science is not only powerful because it provides precise measurements and addresses tensions between the social and the economic: the power of civil science is derived from the ways it produces data about pollution for different audiences in increasingly sophisticated ways. In Galison's (1997) terms, different social groups involved in techno-scientific projects develop a pidgin or creole to describe the role, function and value of objects. This kind of creole is necessary to build common ground between the diverse groups involved in climate policy, and to stabilize its worthiness beyond mere cost. By creating inflexibilities that close negotiation, the rationalist discourses of economic efficiency promoted by neo-liberals threatens permeable boundaries that facilitate interaction between social groups. The abstract commodities of both 'emissions reductions' and credit derivatives, which govern contemporary markets, suggest that their incivility will require new climate approaches that enable such facilitation without reducing participation to a cynical set of experiments about the role of rules and incentives which characterize the paradox of measurable counterfactuals.

Conclusion: Beyond 8%: Resituating Emissions Trading

The case studies of emissions trading schemes in the preceding chapters have all been remarkably resistant to the kinds of civilizing processes proposed by Callon. Scheme after scheme has seen caps on carbon undermined by weak targets or overly generous offset provisions. The Australian federal government's baseline-and-credit 'Direct Action' policy passed in October 2014 is the latest example of this tendency. This policy seems to have *un*learned the last two decades of climate policy, reverting to an effectively voluntary scheme similar to the predecessor of the NSW scheme discussed in Chapter 3. The policy sets sectoral baselines at the highest historic point of emissions, rather than using best-available technology standards. This decision will create windfall gains for business-as-usual fluctuations in emissions and improvements in technology, whilst the limited financial consequences for non-participation will allow the biggest polluters in a field to continue polluting (Green, 2014). Furthermore, the EU appears firmly mired in the ambition paradox discussed in Chapter 6. The latest target designed to stimulate demand for the EU emissions trading is likely to be a cakewalk, according to the European civil society organization Sandbag's October 2014 analysis.[1]

To date, no proponents of carbon emissions trading schemes claim to have achieved greater than 8 per cent emissions reductions over the course of their schemes. Does this mean that the rationalist dream of a cap on emissions reduced in a linear fashion will remain elusive? When considered as part of the history of pollution-control regulation, the answer seems to be, yes. Technological changes through price have not come to pass. Factory and power station owners have not waited, sheep-like, to be corralled into a common regulatory space by a suitable sheepdog-like civil scientist to solve the problems to which emissions

trading has been applied. Rather, spatial and technical fixes have been implemented through science and law to accommodate the demands of industry over and over again. Regulators seldom had the sharp teeth.

The history of civil science presented in this book complicates a view of science as the site of truth about climate change from which facts must be divined. Rather, science is a contested terrain, some of which is occupied through practices of measurement designed to accommodate the demands of industrial expansion. By following the actors historically, this book has brought the 'eco-sciences' into contact with histories of capital (Chakrabarty, 2009).

The calculative power of actors such as mining companies in climate-change policy lies in areas that assess fossil-fuel emissions as being commensurate with biocarbon sequestrations in trees and soils. The qualification and commensurateness of low-cost offsets such as these exemplify the insight (from performativity theories) that calculative power is not the property of individual minds, as formalist and neo-liberal economists insist. Rather, calculation is heterogeneous, as demonstrated by the diverse skills needed to measure carbon in trees through industry-linkage grant partnerships. More subtle forms of calculative power can travel through interests aligning with government satellite data interpretation, as documented in Chapter 4. Economic calculation is distributed and made material only thanks to the centuries-long development of civil scientific authority.

Rescaling politics

The cases in the previous chapters show the substantial political implications of establishing new sites of calculation. These implications are often considered in the two dimensions of borders on maps, but they are in fact three-dimensional. Matters nominally considered to be confined to the ground, such as fish in acidifying rivers in the Adirondacks, shrubs in remote Western Australia, factories in nineteenth-century Tyneside – all were directly or indirectly connected through the currents and fluctuations of air and climate. In each place, experts gathered to resolve concerns by creating new ways of calculating what counts. More prosaically, such connections mean that Marshall Berman's famous epithet for modernity, 'all that is solid melts into air', should not be taken to imply air has a lack of substance. As Timothy Choy (2012) suggests, the fixity implied by the phrase 'all that is solid' is itself historical. Long-standing relations between people, species and the land were disrupted by liberal capitalism, and then again as civil science transcended new limits to

capital's expansion through regulatory laws and agencies. Capital did not lose substance in these atmospheric shifts; rather its substance shifted through new techno-scientific modes of measurement and calculation.

Many of these new modes of measurement have been accompanied by claims to universality. The modernist oppositions between the universal and particular are often presented in the form of paradoxes. These oppositions appear most obviously in rationalist concepts of climate-change science and environmental economists' claims of the innate superiority of emissions trading, which presume the particular must accommodate the universal logic of efficiency and truth. However, the opposition also appears in reactions to romanticism for small-scale operations such as 'small is beautiful'.

Yet the 'civilizing markets' thesis is powerful insofar as it encompasses the universal and particular through a reflexive attitude to science and economics and their affects. Concern is an affective modality to weaken the modernist siloing of climate, economy and politics, opening up new spaces for disagreement. However, through emissions trading it has come unstuck in two ways. Firstly, the sheer complexity of land-based carbon fluxes defies complete accountability through singular standards. In this sense, the many different ways disciplinary approaches are devised to construct baselines and monitor changes present fundamental barriers to a singular, global carbon price imagined by rationalists such as Garnaut.

The 'civilizing markets' thesis posits, optimistically, that the labyrinthine character of carbon accounting does not inherently favour fossil fuel industries but can be overcome by a commitment to revising the distinctions between the scientific, economic and political. However, this book has shown the ways power-station operators and mining companies have exploited abstraction whilst also winning significant windfall gains from free permits and loopholes through political concessions whilst negotiating emissions trading schemes in Europe, Australia and elsewhere (Reyes, 2011a; Reyes, 2014). Inertia, opacity and cumbersome rigidity characterized carbon markets presented in Chapter 3 (NSW GGAS), the Kyoto Protocol Assigned Amount Units presented in Chapter 4, and the market for CERs in Chapter 5. All these schemes ended up far from the pliant transition of entities imagined in economic theory. For this reason, politics rages unrestrained in the 'gaps' (Callon, 2009) between statements about the inherent economic efficiency of carbon offsets and the loopholes and windfall gains. This politics points to the need for a more historically sensitive understanding of regulation of the corporation and its influence. To return to Armitage and Guldi's

provocation, quoted at length in the introduction, 'a true sustainability will involve unthinking the power of terms like "improvement", "development", and "growth", which modern capitalism has inherited from the last two centuries of its historic development, and which are embedded in all economists' definitions of success with knowledge of these events, institutions, and discourses, however, the possible future of action becomes wider again' (Guldi and Armitage, 2014).

This politics has been particularly fierce in Australia, where abundant, shallow coal deposits have shaped more than just the terms of reference for Australian emissions trading schemes. Research agendas are also influenced. Thus, Clive Spash was recruited to the Commonwealth Scientific and Industrial Research Organisation (CSIRO), as an expert in heterodox economics. The organization requires internal review for papers, 'often as a formality' (Spash, 2014: 195). Spash's drafts for a paper entitled 'Brave New World of Carbon Trading' (Spash, 2010a), however, fell afoul of CSIRO's staff policy on public comments about prevailing government policy. Spash's paper drew analogies between the drug *soma* in Aldous Huxley's *Brave New World* and carbon emissions trading. He argued they both operated to distract from addressing life's problems:

> My argument involved a series of points to establish that missions trading is fundamentally flawed as an approach. This involves failures by mainstream economists to take into account economic and social reality such as corporate power, strong uncertainty and the exploitation of the poor to establish carbon offsets. The censorship removed key sentences and paragraphs so that the revised argument took the familiar mainstream environmental economist's line that, while emission trading has its problems, these things require more research and through redesign over enough time, such schemes can be improved and all issues resolved. Strangely enough putting the cut text together created a coherent critique of emissions trading.[2] (Spash, 2014: 197–198)

Spash's concerns point to deeply entrenched divisions between science and politics around the extraction of coal in Australia. Spash claims that CSIRO was particularly keen to protect research interests in carbon offsets and land management that would benefit from offsets (Spash, 2014); whilst the CEO of CSIRO argued that the organization 'cannot be a trusted advisor [to] government, industry, the community and people of Australia and at the same time publicly advocate or criticize a particular policy position of government or opposition'.[3] Regardless

of the merits of the case, the wider point here is that the civilizing potential of emissions trading is embedded in political priorities. Even more centralized controls of policy based on changing measurements of abstracted carbon fluxes will not drive rapid decarbonization, although such approaches may be compatible with it.

For example, Reyes (2014) calls for separate and ambitious EU targets for greenhouse-gas emissions, renewable energy and energy efficiency as a way of guarding against expensive, centralized technologies such as nuclear. He also calls for ambitious minimum-energy performance standards for buildings and fuel quality, as well as legislation to prevent the kinds of corporate lobbying that has hamstrung the EU ETS and other carbon markets. This will certainly be the kinds of complementary policies necessary if the 2-degree guardrail is to be missed.

Australian experience with emissions trading, furthermore, suggests that a more diversified economy and a moral framework for phasing out fossil-fuel reliance are required for emissions trading to 'civilize markets'. Concrete initiatives in such diverse sectors as energy, transport and food are seeking to rebuild this framework by using more democratic legal forms than ones demanding shareholder maximization (Morgan and Kuch, 2014). These recent initiatives complement a longstanding trend to demonstrate 'reductions in emissions of greenhouse gases independently of the success or otherwise of the current [UN-centred] regime and post-2012 architectures for governing climate change' (Okereke et al., 2009: 2).

My current research with Professor Bronwen Morgan has examined how these initiatives exist along a spectrum from activism to enterprise. Direct anti-coal activists have started community food initiatives; cycling activists may start car-sharing initiatives designed to strip automobility of both its invidious cultural markers of status and burdens of ownership. Such initiatives have seen over 25 per cent fewer kilometres travelled when introduced into urban settings, with associated benefits due to the use of smaller, more efficient vehicles (Martin and Shaheen, 2011). These are some of the ways the key terms of 'growth', 'prosperity' and economic activity have been retooled for the kind of sustainability that Armitage and Guldi suggest will be necessary..

It is tempting to locate these initiatives in the lineage of private-interest innovation: start-ups that will require regulation just as the taxi and hotel industries do now. The preceding chapters have touched on the many ways that corporate interest, often privately owned, has incurred upon regulation of public infrastructure and environmental commons. Indeed, regulation of economic activity itself seems to be

increasingly shifting away from the nation-state, as private carbon offset standards, self-regulation and certification regimes proliferate. In the financial arena, where enforcement is concerned, private arbitration has subsumed license suspensions, banning, and even criminal prosecutions (Nicholls, 2014).

There are many ways by which we have resisted the location of these sustainability initiatives in the field of corporate regulation, some of which run against the grain of neo-liberalism entirely. These initiatives signal a broader shift in regulatory politics in three ways. First, advocacy focused on government is increasingly supplemented or even displaced by social mobilization focused on communities (Hale, 2010). A seismic shift in residential energy politics has occurred since John Howard's office wrote the terms of reference for his emissions trading scheme as I started this research. Then, the number of households in Australia with solar energy systems numbered in the hundreds. Tumbling panel prices and generous state feed-in tariffs have increased that to over 1.6 million. As Beck Pearse notes, the nascent lobby group for solar (made up largely of climate campaigners), Solar Citizens, 'seem less worried about the carbon trading scheme than they are about the RET and various state laws that stand in the way of renewable energy' (Pearse, 2014). Furthermore, the disillusionment with carbon pricing has seen a shift towards campaigning directly at the site of fossil-fuel projects, complemented by divestment campaigning. As Pearse observes:

> debate over policy and law is also different when fossil fuel commodities are the focal point of discussion. Unlike carbon pricing politics, the contest over coal and gas expansion has involved a direct confrontation with the state and federal agencies ticking boxes on new projects. People are calling for: moratoriums on gas and new coal; reform of licence approvals; fair land access laws; reform of [biodiversity legislation]; an end to environmental offsetting; inquiries into corruption and more. In effect, the political ask is for just and direct ways to deal with the blight of fossil fuel dependence. (Pearse, 2014)

Secondly, an emphasis on social goals is augmenting the narrower focus on environmental goals, thereby addressing blind spots in the accounting of emissions such as the ones I observed in my time working under the NSW GGAS. Community food and energy schemes are as much about finding new avenues for meaningful work as they are about stopping catastrophic climate change. Thirdly, this new politics has seen new ways of coming to agreements, establishing ways of

trading and working together and avoiding harming. In sum, new ways of practising law (Morgan and Kuch, 2014). As Will Davies, recalling his experience in working for the International Cooperative Alliance, boldly claims, 'twenty public-spirited lawyers could change the world' (Davies, 2013). As he observes it is not civil rights or legal aid lawyers to which he alludes. Rather, it is lawyers who can manipulate equity, voting rights, debt, share, audit and so on. In seeing, he says, 'how far [these] can be tweaked in various directions, before they become something else[,] ... one starts to imagine a wholly different economy, simply through considering how freedoms, powers and responsibilities might be combined differently, via subtly redesigned legal instruments'.

Taken together these new initiatives may hold the promise of civilizing markets by re-establishing civility in a more humble economic setting. At the very least, modifying ownership and control of carbon offset projects on a more just basis could provide a route out of the increasingly stifled Clean Development Mechanism project cycle by connecting socially necessary proponents with offset buyers. This is just one good reason to move away from corporate forms designed to support economic growth concepts borrowed from nineteenth-century physics (Mirowski, 1989). However, the challenge of such a move should not be understated. This book has documented the many connections between practices of resource measurement and modern political economy. Nevertheless, if new sustainable initiatives can avoid the kinds of disastrous inertia and path dependency that sociologists have feared from Weber's warnings about the iron cage through to MacKenzie's (2011) diagnosis of the global financial crisis, then any stumble or, indeed, fall of emissions trading from centre stage to supporting act may be a relief after all.

Notes

Introduction

1. For an overview and analysis of current and proposed emissions trading schemes and their use of offsets, see (World Bank and Ecofys, 2014)
2. See, especially, Maurice Newman's interview with Emma Alberici on Lateline http://www.abc.net.au/lateline/content/2014/s3990190.htm (accessed 23 April 2014)

1 The Rise of Emissions Trading as a Market Mechanism and the Promise of 'Civilized Markets'

1. Garnaut (2011) Carbon pricing and reducing Australia's emissions Update Paper 6 http://www.garnautreview.org.au/ p. 8.
2. See Clean Energy Regulator: http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Fixed-Price-2012–15/Pages/default.aspx (accessed 24 May 2014).
3. See https://www.google.com/trends/ using terms 'carbon trading', 'carbon tax', 'carbon markets', 'emissions trading'.
4. Stavins, 25 Sept 2014 tweet https://twitter.com/RobertStavins/status/515113867580817408
5. https://www.cdp.net/ (accessed 3 October, 2014).
6. The concept of 'transaction costs' pioneered by Coase and his Chicago school colleagues departs from the neoclassical assumption of 'perfect' markets, recognizing instead that all forms of socio-economic coordination have some cost attached to them. These costs include contracts, negotiations and uncertainties that characterize the creation and running of institutions. Law is just another institution to be criticized in terms of its effects on price. The proposition that emissions trading delivers whatever level of emission control is politically required at the most efficient way, at minimal cost to society is a variant of transaction cost economics.
7. Most influential of this early research is Dales (1968). See Meidinger (1985) for a critical account of the role of flexible permits in the formation of the US air pollution regime.
8. Voss (2007) usefully charts this transition by imposing a framework of linear innovation on the formation of emissions trading as a policy regime.
9. This table is necessarily a caricature of these positions and should be read critically. Overlaps occur, particularly between performative and 'critical left' positions, most notably Lohmann's (2005) use of Callon's concepts of framing and overflows.
10. See, for example, Callon's appropriation of Coase's work in (Callon, 1998).

11. Examples of linear accounts of the development of emissions trading from economists involved in the construction of markets include: Tietenberg (2006) and Stavins (1998; 2010).
12. Aspers (2009) contrasts 'spontaneous' markets, where goods are exchanged under conditions of crisis or repression, with 'organised' markets where order and cohesion prevail. He situates performativity in studies of 'organised' markets; however, the concept has also been used with reference to market formation.
13. Callon argues that 'operators of translation are the basic modules on which *agencements* are built. Acting means translating, and translating means influencing the capacities and modalities of action, since it means establishing links, connections, circulations, exchanges of properties, and original distributions' (Callon, 2008b: 25)
14. 'The list of actors involved in this kind of experiment (i.e., the identity and force of the different actors that are to be engaged in the experiment and alter its course) is not defined *a priori* [as] the *in vivo* experiment's main objective is to make actors appear' (Callon and Muniesa, 2005: 178).
15. Prominent economists whose modelling work has sought to inform policy in a similar manner in other 'advanced liberal democracies' include Garnaut (2008) and Stern (2006).
16. For example, Holm shows that the transformation of traditional fishermen into 'selfish individual economic agencies' first required immense scientific, material, technical and institutional investment in order to transform the sea into an aquarium and wild fish into cyborgs (Holm and Nielsen, 2007).
17. Foucault examined how such concepts and modes of thinking arose in response to certain historical events, such as a grain shortage. He cites a grain shortage *(la dissette)* as a pivotal contributor to the transition from physiocratic to *laissez faire dispositifs* (Foucault et al., 2007). The significance of the market in this context is not that it was a precursor to modern political economy, but that the basic right of individuals to grain under the physiocratic model of government became subsidiary to the needs of preventing a 'scarcity event', namely a grain shortage. Several people or families were sacrificed to starvation for the benefit of the whole population.
18. Didier (2007) criticises MacKenzie on this basis – that his analysis of the Merton-Scholes equation does not pay adequate attention to context.
19. However, see for example Lovell (2012) for analysis of the role of consumption practices in climate policy.
20. He developed a framework for examining the conditions under which private bargaining, rather than taxation, would provide an 'economically efficient' allocation of an externality (Coase, 1960).

2 Marketizing Civil Regulation: Acid Rain Regulation as the Experimental Bridge to Carbon Markets

1. Muriatic or hydrochloric acid is an outcome of the Leblanc production process. The innovation of the Leblanc process over eighteenth-century methods of soda production was the addition of limestone to the soda-production process, allowing for mass production (Bensaude-Vincent and

Stengers, 1996: 161–170). The waste product resulted from the first stage of the process in which common salt was treated with sulphuric acid to give 'saltcake' (sodium sulfate) and hydrogen chloride. The saltcake was then furnaced with limestone and coal to give the so-called 'black ash'. This, on lixiviation with water, gave sodium carbonate solution and residue 'alkali waste', consisting mainly of calcium sulfide, calcium carbonate, and half-burned coal (MacLeod, 1965).

2. 'Intolerability' was a term used as a defining the threshold for numerous forms of civil legislative regulation in Victorian Britain (MacDonagh, 1958).
3. The independence of the Chief Inspector position was lost when the role of the Inspectorate to administer grit, dust, smoke and other industrial emission issues was transferred to the Health and Safety Executive. From 1906–1975, the Inspectorate came under the purview of five different departments, including Health and Local Planning. It finally fell under the Department of Environment.
4. '[T]he history of risk distribution shows that, like wealth, risks adhere to a class pattern only inversely' (Beck, 1992: 35).
5. Hydro-fluorocarbon producers have in recent years been in a similar position thanks to the Clean Development Mechanism (MacKenzie, 2009b). See Chapter 5 for analysis of this issue.
6. See especially (Ashby and Anderson, 1977; Ashby and Anderson, 1976) and (Dingle, 1982). Ashby and Anderson (1976) develop the concept of 'responsible public opinion' based upon the appeals to reason in expert arguments about the cause of health issues associated with domestic hearth smoke regulations in the 1840s. Ashby and Anderson's 'public' is thoroughly Benthamite. Londoners, they argue, understood the trade-off between the 'pokeable companionable' open fires that stultified transport and caused fogs, death and illness and closed stoves burning anthracite or coke. It was expert intervention through appeals to 'responsible public opinion' that was necessary for the appropriate technologies to be adopted.
7. Smith gave evidence to the 1878 Noxious Gases Royal Commission stating that 'the act of inspection causes people to suppose there is no redress' in tort (Pontin, 1998: 664).
8. This is the main argument of neo-liberals, including Coase and Posner. Glaeser (2003) formalizes and applies this approach to the development of the regulatory state.
9. Neo-liberal economists following the Chicago school and those following Porter's competitiveness framework have provided different answers to whether increasing environmental regulations are economically efficient. Porter's (1995) account of 'win-win' environmental regulations has been influential in management studies and urban planning, but its core findings and case studies are deeply contested by neoclassical economists (e.g., Jaffe et al., 1995).
10. William Gossage pioneered a technique to condense the troublesome hydrogen chloride gas from his alkali works in the 1830s. A derelict windmill was filled with gorse and brushwood and the packed tower then irrigated by a downward stream of waste. When hydrogen chloride was passed down through the tower, it was absorbed by the water and turned into hydrochloric acid (Dingle, 1982: 539). This acid could be used in bleach production.

However, transportation was problematic because railways charged additional fees for its carriage, so supplies were localized and often outstripped demand.

11. An exception is Croser (2011). There is no mention of electricity in any studies covered by Rose, Valverde and O'Malley (2006). In these studies, analysis of the relationship between sovereign power and governmentality has tended to focus on the ways populations are governed through various apparatuses to control human bodies.
12. It is noteworthy in this context that electrification, along with public health and longevity, is often used as a proxy for modernization in international development discourse.
13. In 1975 there were 15 power stations operating in central London. By 1985, there were just three (Boehmer-Christiansen and Skea, 1991).
14. The most heavily publicized of these was Svante Oden's (1968) report attributing declining salmon catches, and an uncertain threat to Nordic forests, to acidification, which was based on 15 years of monitoring pH changes at thousands of sites across Scandinavia.
15. Some authors (e.g., Alcamo et al., 1990: 4) list two additional abatement options: simply decreasing demand for fuel or burning it more efficiently.
16. Boehmer-Christiansen (1991) provides a full account of the political and cultural influences on sulphur regulations in Germany, where FGD technology was mandated for use on power stations, and Britain, where it was not.
17. Critical loads have underpinned the Protocol on the Further Reduction of Sulphur Emissions (Oslo, 1994), and the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg, 1999), and also supported the EU Directive on National Emission Ceilings (2001/81/EC). Critical loads are currently used by British and Australian regulatory authorities in a range of environmental regulations (Whitehead, 2009).
18. The most notable of these events occurred in 1948, when a low-altitude air inversion – a change in normal relationship between air temperature and altitude – over Donara, Pennsylvania, trapped industrial emissions, killing 20 and making some 6,000 ill. (On the formative years of the EPA, see Jasanoff, 1990; Jasanoff, 1992).
19. Sulphur oxides, hydrocarbons, particulates, carbon monoxide, photochemical oxidants, hydrocarbons and nitrogen oxides.
20. The EPA also had power to enforce 'secondary standards', introduced to monitor sulphur dioxide. These were designed to protect agriculture and ecosystems and to take account of such aesthetic considerations as 'visibility' by controlling emissions rates of individual pollution sources or specifying control technology standards. However, it is unlikely that this pressure had much bearing on the 1970 or 1977 Clean Air Acts. Daly notes that, although the maintenance of pristine visibility was a concern for Western environmentalists, 'the principal sources of visibility degrading sulphates in the West were smelters, not power plants (ironically, emission standards for smelters were relaxed the same year that the amendments were devised). As a result, even dramatic reductions in the sulphur emissions of newly constructed western power plants would have negligible effects on visibility in this region' (Daly and Mayor, 1986: 158).

21. These initial standards were establishing through state-based plans, set a rate of 1.2 pounds of SO2 per million BTU. A variety of abatement methods were acceptable: 'the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated' (quoted Daly and Mayor, 1986: 146).
22. See Ellerman (2000: 14–15) and Hays (1998) for Environmental Economic and Environmentalist perspectives on these amendments respectively.
23. By 1985, 83 per cent of power plant SO_2 emissions came from generating units not meeting the 1971 standards (Ellerman, 2000: 17)
24. For example 'red rain' menaced cartoon vehicles in *Transformers* and one character's hair turned bright green in one episode of the sitcom *Perfect Strangers*.
25. To take two prominent (still influential) examples: the Natural Resource Defense Council was formed in 1970; and the Environmental Defense Fund formed in 1967 around the issue of DDT.
26. Jasanoff (1992) cites Senator William Proxmire's 'golden fleece awards' for wasteful research in the 1970s and Representative John Dingell's aggressive inquiries into scientific misconduct and indirect cost charges by universities during the early 1990s as examples.
27. The decision to ban Aldrin/Dealdrin in the United States exemplifies this tendency (Gillespie et al., 1979; Jasanoff, 1992).
28. Reagan appointed Anne Gorsuch to lead the EPA in 1981. Her *Washington Post* obituary recounts 'a striking woman with jet-black hair ... television-star looks and perfect manicures' who 'wore fur coats and smoked two packs of Marlboros a day; her government-issued car got about 15 miles per gallon of gasoline'. She could charm opponents, but 'firmly believed that the federal government, and specifically the EPA, was too big, too wasteful and too restrictive of business'. Denver's *Rocky Mountain News* once quipped that 'she could kick a bear to death with her bare feet'. Republicans and Democrats alike were uneasy at a number of developments under her watch: budget cuts for research and enforcement as well as steep declines in the number of cases filed against polluters, and the acceleration of federal approvals for the spraying of restricted pesticides (Sullivan, 2004).
29. Economic values of health, materials, and general ecosystem damages were largely excluded in the final NAPAP assessment. For the areas that were analysed, the approach was to determine how the economic values of certain resources would be affected as a result of changes in acidic deposition. The aquatic effect assessments were targeted at recreational anglers in cold-water fisheries in the sensitive Northeastern United States (Maine, New Hampshire, New York and Vermont).
30. For the role of environmental NGO and other civil society contributions to this construction see Ågren (2004).
31. See Ellerman (2000) for a detailed account of the political negotiation of baselines.
32. The European RAINS Integrated Assessment Model had an analogous device, namely an agreement to prevent percentage reductions exceeding 5 per cent of critical loads. This critical load figure provided the parties invested in the model with both the justification and mandate to pursue abatement

strategies in their negotiations with other parties to the LRTAP (Lidskog and Sundqvist, 2002).
33. Policy expert interview, 5 March 2009, Sydney.
34. Sunstein (1990: 433) exemplifies this: 'A fundamental virtue of an emissions trading program is that it would create dynamic incentives for pollution control by making it profitable for people to develop good pollution control technology'.
35. This was calculated as the emissions rate associated with fuel costs and capital costs associated with the use of burning that fuel. A single equation incorporating transportation rates, mine mouth costs and distance between the two was devised by the environmental economists (Ellerman, 2000: 80–81).
36. This concern could fall within the bounds of the linear relationship between deposition and ecosystem recovery.
37. The 1998 NAPAP report stated that reduced sulphate concentrations in precipitation in the Northeast was directly attributable to reductions in emissions downwind in the Ohio Valley Basin. Some of the greatest reductions in wet sulphate deposition occurred in the mid-Appalachian region, including Maryland, New York, West Virginia, Virginia and most of Pennsylvania. Wet sulphate deposition decreased 40 per cent in the Northeast and 35 per cent in the Midwest and mid-Atlantic since the early 1990s. Reductions of 25 per cent have occurred in the Southeast (National Acid Precipitation Assessment Program, 1998).

3 Governing Carbon Emissions: NSW GGAS

1. This unbundling was a four-part process: (1) the deregulation of those functions where competitive markets could be introduced, typically wholesale generation and retail services; (2) making transmission and distribution services that remain regulated available to all users under mandatory, open-access arrangements; (3) creating physical and financial markets for electricity trading; and (4) the creation of an independent system operator to administer the transmission system (i.e., generation dispatch and reliability maintenance) (Woo et al., 2003).
2. The classic work in the 'embeddedness' paradigm is Granovetter's (1998) account of the social networks that transformed themselves into an electricity-generation industry through the establishment of corporations, governance arrangements and experimental demonstrations. For the purposes of the present discussion, the central claim here is that the social connections of industry players explain the economic ties that subsequently developed.
3. A considerable body of regulatory studies has been devoted to documenting the details of electricity governance and its relationship to societies. (See, especially, Levi-Faur, 2006; Majone, 1991; Stewart, 2001; Braithwaite, 2008; Levi-Faur and Gilad, 2004; Vogel, 1996; Gunningham et al., 1998; Wilkins, 2008; Helm, 2006).
4. The considerable body of literature on ecological modernization has documented how, more broadly, questions of economic growth have been made compatible with continued or increasing natural-resource extraction and use. (See, especially, e.g., Fisher and Freudenburg, 2001; Hajer, 1995; Mol, 2001).

5. Outhred (2004: fn1) and others have suggested this reflects a failure to implement the original brief from the premier's conference endorsing a national electricity market 'to encourage and coordinate the most efficient, economic and environmentally sound development of the electricity industry'. The final report of the Council of Australian Governments' (COAG) energy market review noted: 'Government policy makers anticipated that energy market reform, and its acceleration, would lower the average greenhouse gas intensity of energy. Analysis now shows that far from achieving a 14 Mt reduction in 2010, as estimated in Australia's Second National Communication to the United Nations Framework Convention on Climate Change, energy market reform is now estimated to result in an increase of 0.1 Mt CO_2-e by 2010'.
6. In four of the six states, the utilities were vertically integrated. In the remaining two states (NSW and QLD) the distributors were nominally separate from the generators.
7. The restructuring of NSW's state power utilities involved firstly their corporatization through several reform processes carried out by both the Wran and Greiner governments (Wilkenfeld and Spearritt, 2004). At the completion of the state reform processes, the corporations were publicly owned in the case of NSW and WA, and privately in the case of Vic and Qld.
8. The chair of the NGMC, John Landels, reported to a meeting of premiers and chief ministers by implicitly attacking the logic of central planning that resulted in redundant plant construction, noting 'the environmental benefits to Australia which will result from this process, as there is potential for a significant reduction in greenhouse gases by deferring the need for additional generating capacity' (Anon, 1997: 46).
9. In 1992 Australia's electricity industry had a total installed capacity of 34.5 GW, total annual electricity generation of 128 TWh, and total debt of $23 billion due to the excess generation capacity (ESAA cited in Diesendorf, 1996).
10. The NEM is sub-divided into regions, each of which has a regional reference node at which regional reference prices are calculated. The price any other node within a region is determined by a fixed ratio to the regional reference price (Outhred, 2000). See Outhred (2003; 2004) for detailed analysis of the restructuring of state-based systems into the National Electricity Market.
11. The NGRS was developed in response to the Interim Planning Target for stabilizing emissions of those greenhouse gases not controlled by the Montreal Protocol. The target was to stabilize 1988 levels by the year 2000 and reduce these emissions by 20 per cent by the year 2005. It was subject to the (familiar) caveat that Australia would not adopt response measures that would have net adverse economic impacts nationally or on Australia's trade competitiveness, in the absence of similar action by major greenhouse-gas emission-producing countries (Diesendorf, 1996: 35).
12. He furthermore proposed (1997) price-based measures, use charges, taxes and subsidies to persuade polluters to reduce their discharges and rights-based measures and 'create rights to use environmental resources, or to pollute the environment, up to a pre-determined limit, and allowing these rights to be traded'.
13. Outhred et al. note that applying the constraint to the generators would raise the possibility of legal challenge under s92 of the constitution (Trade between the states to be absolutely free).

14. These compete in the sense that residential households can cook with either electricity or gas.
15. The term *benchmark* emerged from nineteenth-century surveying practices, indicating an observable mark from which measurement was conducted. Online Etymology Dictionary. Douglas Harper, Historian. http://dictionary.reference.com/browse/benchmark (accessed: November 10, 2011).
16. The consequences of this secrecy are discussed with regard to international carbon offsets in Chapter 5. For example, Chinese emissions factors are a closely guarded state secret.
17. Bob Carr became NSW premier during the March 1995 election. It was a narrow victory for Labor, claiming 50 of 99 seats in the Legislative Assembly. This represented years of hard work for Carr – a 'fanaticism required to win back the heartland seats' (Carr, 2002: 45) that meant rising early on weekends to tap into the resentment of the working classes marginal electorates, most notably in the Illawarra and Hunter regions, where unemployment had been growing. As Neville Wran, in whose cabinet Carr held the position of environment minister noted, '[Carr's] greatest achievement was to keep on winning elections' (Dalley, 2005).
18. Policy expert interview, 12 November 2008, Sydney.
19. These provided regular emissions data that was more accurate than the mass estimate approach based on multiplying power sent out by a single-figure factor of pollutant concentration.
20. During the first phase of the US SO_2 permit allocation, some $6bn were mostly distributed for free as Ellerman (2000: 36) quipped: '[W]ith that sort of rent on the table, one would certainly expect to see serious rent seeking, and Washington did not disappoint'.
21. In December 2001 the NSW government released a position paper proposing reform of the licence condition. A number of options papers were released on different aspects of the scheme – quantifying retailer targets, the rules for crediting low-emission generation and energy efficiency actions, and possible trading mechanisms.
22. The amendment to the Electricity Supply Act (1995) inserted Part 8A, 'establishing a scheme that provides for the reduction of greenhouse-gas emissions associated with the production and use of electricity and encourages participation in activities to offset the production of greenhouse-gas emissions:
    (a) by setting out State greenhouse gas benchmarks and providing for the calculation on the basis of these of individual greenhouse gas benchmarks for certain participants in the electricity industry and large users of electricity, and
    (b) by providing a scheme for the recognition of activities that reduce or promote the reduction of greenhouse-gas emissions and enable trading in, and use of certificates created as a result of those activities for the purpose of meeting greenhouse gas benchmarks, and
    (c) by imposing penalties for failure to meet greenhouse gas benchmarks in any year'. However the minister retained ultimate responsibility for the licensing conditions and my interviewees struggled to imagine a scenario whereby a major (former state-run) retailer would be stripped of its license.

23. Concerns about the ESF provisions were only partially addressed by this rule, which was targeted at industrial users of aluminium, steel making and paper. David Hemming explained that the rule 'provided [large users] with opportunities to reduce energy use and be credited for it'. He stated that they were a 'hard bunch to get across the line, because even though NSW had the power to make the policy, you don't want to do it and have half your industry offside'. Although Hemming 'wasn't aware of any major publicity campaigns [against the government]; it was probably done less so publicly ... if you're after the hearts and minds of NSW, they probably wouldn't give a toss. But what [the aluminium industry] did was they had excellent access at all levels of government. So we'd be talking to them, they'd say, 'On this day we're seeing the Premier, on this day we're seeing the Treasurer', so it was clear that they had good links; I think to his credit, the Premier held the line and said, 'No, we're having a scheme' and we'll do what we can to make sure your business isn't cruelled. I think the outcome we had achieved both those objectives' (Hemming 2009).
24. IPART administered the licence condition compliance annual reports and the reduction strategies that were negotiated with the minister.
25. http://www.ipart.nsw.gov.au/about_us/about_us.asp <accessed 12 April 2009>
26. Two members appointed by the minister of energy and one member each from the Nature Conservation Council and the Australian Consumers Association.
27. Credits are created under the generation rule when retailers purchase power from a category of generators with greenhouse-gas emissions less than those of a benchmark calculated from a NSW 'pool'. See (Passey et al., 2008) for a detailed discussion and critique of these calculations and classifications.
28. These origins are instructive to the concepts of socio-material *agencement* (Callon, 2007b) because they implicate crisis, rather than the disagreement and affect discussed with reference to 'hot' situations.
29. Cameral government refers to government with a judicial or legislative chamber
30. '*Kontinuirliche, beständige und nachhaltende Nutzung*.' Hans Carl von Carlowitz's full title: *Sylvicultura Oeconomica oder Hauswirthliches Nachricht und Naturmässige Anweisung zur Wilden Baum – Zuch*t (Vehkamäki, 2005: 3).
31. The creation of national parks also led to 'conservation refugees' as colonialists displaced indigenous peoples whose nomadic cultivation practices were viewed as uncivilized (Dowie, 2009).
32. See, for example, Reyes and Gilbertson, 2009; Lovell and Liverman, 2010; Reyes, 2011a.
33. At maturity: height > 2 m, projected cover > 20%; area greater than 0.2 ha; established (planted or sown) on or after 1 January 1990; on land that was predominantly non-forest on 31 Dec. 1989; exclude areas that were forest on 31 December 1989.
34. The NSW Forests Pool is primarily hardwood plantations, established 1998–2002.
35. Forestry expert interview, 24 April 2009, by telephone.
36. Plantations are stratified according to data derived from yield tables, or estimated where no data is available (for example where plantations were less than ten years old). Climatic and soil data are also used to estimate site

productivity and stock – that is, how quickly the trees will grow and how much carbon is in them. These inputs are then modelled to produce estimates of forest growth and carbon stock over time for each stand. The derivation of total carbon relies on allometric relationships between standard tree measurement variables to obtain total tree volume and total carbon from tree crown, stem and roots. Forests NSW Pool is accompanied by 'debris' and 'soil' pools that account for the movement of carbon between the forests, debris and soil (O'Brien, 2005; Welch et al., 2007). The ultimate aim is for Forests NSW to integrate its carbon model with its regular wood-flow model, thereby enabling optimization of timber and carbon production across their forestry estates.

37. See Crossley (1979) for a summary of these campaigns, including some sample public relations material.
38. A number of measurement methods were discussed and then implemented by the regulator. See MacGill et al. (2003: 27–32) for a review and assessment.
39. IPART (2009) required two additional criteria to be fulfilled: that the project be implemented in NSW after 1 January 2002 and in the ACT after 1 January 2004, and result in reduced greenhouse-gas emissions after 1 January 2003 in NSW and after 1 January 2005 in the ACT. Also, in the DSA Rule, the person responsible for creating NGACs is termed 'the Abator'. Initially, the Abator for a DSA project is the person contractually responsible for paying for the energy consumed at the abatement site – such as residents of houses. However, such persons may choose to give written permission to others to create NGACs on their behalf. This process is called 'nomination' and it enables third parties to specialize in creating NGACs from DSA projects implemented by others, particularly at smaller, decentralized sites.
40. The company was also formed with ex-Brotherhood of St. Laurence chief and 'social entrepreneur', Nic Frances, author of *The End of Charity* (Frances and Cuskelly, 2008).

4 The Technopolitics of National Carbon Accounts

1. Freeman Dyson's 1976 calculations are often cited as the first prominent study of carbon-sink potential (Backstrand and Lövbrand, 2006: 50).
2. LULUCF is the acronym for 'Land Use, Land Use Change and Forestry'. Forestry generally refers to silviculture as in the previous chapter; land-use change refers to changes to land that enact carbon stock changes such as conversion of natural ecosystems to permanent croplands, conversion of natural ecosystems for shifting of cultivation, conversion of natural ecosystems to pasture, abandonment of croplands, abandonment of pastures, harvest of timber, and establishment of tree plantations (Watson et al., 2000: 1.2.111). These latter categories may be considered land-use depending on the temporal scope.
3. A second agreement (discussed in the next chapter) allows industrial countries to buy credits from the 'flexible mechanisms', primarily the Clean Development Mechanism derived from projects in the developing world.
4. Article 4, paragraph 1(a) of the UNFCCC states that parties must, 'Develop, periodically update, publish and make available to the Conference of the

Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties'.

5. Three features of the UNFCCC have precedents in earlier agreements, especially the Montreal Protocol on Substances that Deplete the Ozone Layer and Regional Seas programme: Firstly, the role of a UN environment program in assessing the science to prescribe parameters for negotiations; secondly, that a legally binding framework convention be negotiated, to be followed by more specific legally binding protocols later; thirdly, that commitments embodied in the legally binding agreements take the form of targets and timetables for controlling emissions (Victor, 1995).
6. The core of the Kyoto Protocol is the undertaking of its 'Annex I' signatories (the industrialized countries). They have pledged that by the end of the 2008–2012 first 'commitment period', they would have limited their greenhouse-gas emissions to agreed proportions of their 1990 levels (93 per cent for the United States, 92 per cent for the European Community overall, 108 per cent for Australia, and so on).
7. The UNFCCC expert review of Australia's Kyoto Accounts took issue with this claim. (See UNFCCC, 2009).
8. 'Boundary maintenance' between technical, economic and political domains has been particularly intense in expert attempts to finance deforestation prevention mechanisms in tropical countries in return for ongoing industrial emissions in the North (Ebeling, 2008; Macintosh, 2010).
9. Higher resolution imagery is now available with Landsat-7. However, it remains to be seen how this will affect the negotiation of Article 3.3 and 3.4, which will take effect during the Second Commitment period of the Kyoto Protocol. Other activities not counted, although potentially amenable to Australia meeting second-period commitments, include loss of carbon from soils and biomass due to overgrazing, increases in carbon stored in soils due to reduced tillage, and increases in carbon stored in soils from changes to forest stock in rangelands.
10. http://unfccc.int/essential_background/kyoto_protocol/items/1678.php (viewed 28 August 2011)
11. The IPCC Special Report on LULUCF notes that 'Certain definitions of ARD could result in Parties receiving "credits" (i.e., additions to their assigned amounts) for activities that cumulatively result in an increase or no change in atmospheric CO_2 (type I discrepancy). Conversely, certain definitions could result in Parties receiving debits (i.e., deductions from their assigned amounts) for activities that result in reductions or no change in atmospheric CO_2 (type II discrepancy)' (Watson et al., 2000: / s part 3.3.2.2).
12. Whereas all land-based emissions for a basket of six biomass types must be reported, only the items in Articles 3.3 and 3.4 are subject to mandatory accounting by parties to the Kyoto Protocol.
13. Kevin Rudd's successful election campaign in 2007 was fought on the basis that he would sign the Kyoto Protocol and 'take action on climate change'.
14. As a signatory to the Framework Convention, Australia is subject to a number of decisions which have been made regarding reporting requirements for human-induced greenhouse emissions in six sectors: energy

(including stationary energy and transport); industrial processes; solvent and other product use; agriculture; waste; and LULUCF. According to its report to the UNFCCC under the Kyoto Accounts, estimates contained in Australia's inventory current at the time of COP.3, Australia had a net LUC.F (land-use change and forestry) emission in 1990. The reports of COP-6 bis and COP-7 record Australia's eligibility under Article 3.7 in the second sentence. All of Australia's inventories submitted and reviewed since COP.3 consistently report a net LUC.F emission in 1990 (Commonwealth of Australia, 2008).

15. See especially Pearse (2007: 97–100) and Hamilton (2007: 70–95).
16. http://www.riotintoironore.com/ENG/operations/497_pastoral_stations.asp (viewed 12 July 2009).
17. Masks are thresholds in remotely sensed data that have been cross-checked ('ground truthed') with specific events or processes like fire.
18. South Australia, then other states established legislation to criminalize land clearing on the basis of Landsat data. (See Bartel, 2004).
19. In 2004, the Queensland Parliament passed the *Vegetation Management and Other Legislation Amendment Act*, which aims to improve the protection for remnant vegetation and reduce greenhouse emissions by phasing out broad-scale clearing of remnant vegetation by 31 December 2006.
20. In 1997, the NSW Parliament passed the *Native Vegetation Conservation Act*. Farmers locked Premier Carr at Walgett Airport in 1998 to protest the laws (NSWAO, 2006). In a recent book, Carr (2008: 359) notes the policy 'immediately faced opposition from farmers. They campaigned against the government in the 1999 state elections, putting billboards up attacking the policy throughout rural NSW. In the next three state elections, Liberal opposition leaders were to advocate its abolition'.
21. 'There is nothing novel in the idea that property is a responsibility as well as a privilege.…' Judge Napier ruling in *Backhouse vs. Judd* [1925], SA Supreme Court (cited in Raff, 2000).
22. 'Statewide Landcover and Trees Survey – Methodology' http://www.nrw.qld.gov.au/slats/meth.html (accessed 20 July 2009).

5 'Economists in the Wild': Clean Development and the Global Politics of Carbon Offsets

1. The 'net accounting' approach combined with flexible mechanisms to reduce mitigation costs for developing countries were the primary means by which the tensions between industrialized countries' fears about costs and developing countries demands for compensation were reconciled. The flexible mechanisms allowed countries to fund emission-reduction projects in 'Parties not included in Annex I' (developing countries), and count the 'Certified Emission Reductions' from such projects against their Kyoto commitments.
2. Data from the official Norwegian government portal indicates that oil production increased over 20 per cent from 1988 to 1990 http://norway-portal.mfa.no/en/Norway – -the-official-site-in-the-United-States/ARCHIVE/business/businessnews/oilproduction/ (accessed 1 February 2010).

3. FCCC/CP/1995/7/Add.1 Decision 5/CP.1 – Activities Implemented Jointly under the pilot phase. <http://unfccc.int/resource/docs/cop1/07a01.pdf#page=18> accessed 15 January 2010.
4. A second pilot project supporting the roll-out of energy-efficient lighting in Mexico commenced at a similar time with similar aims to the scheme described in Chapter 3 of NSW GGAS.
5. The assignment of a 100-year GWP value to methane is notable because: (a) research suggests that its climate-forcing effects are quite short-lived and intensive; and (b) the release of CH_4 decomposition of plant matter under melting permafrost and undersea clathrates is considered an important feedback in scenarios that consider global warming over longer time horizons (IPCC, 2007a).
6. FCCC/CP/1995/7/Add.1 p. 15: *The Conference of the Parties Decides that …* 'Parties may use global warming potentials to reflect their inventories and projections in carbon-dioxide-equivalent terms. In such cases, the 100-year time horizon values provided by the Intergovernmental Panel on Climate Change in its 1994 Special Report should be used. Parties may also make use of at least one of the other time-horizons provided by the panel in its 1994 Special Report'.
7. FCCC/KP/AWG/2009/MISC.10 p. 3–5.
8. FCCC/KP/CMP/2011/10/Add.1 p. 23.
9. These are a number of decisions made at the 7th COP meeting, in 2001. Michaelowa et al. (2007: 8) note that although they could be changed easily, 'there has been a tacit consensus that changing a part of them would destroy the carefully crafted equilibrium and jeopardize the implementation of the Kyoto Protocol. Nevertheless, some amendments have been made over time'.
10. In most accounts of the myth, an oracle declared that the next man to enter the city of Phyrgia driving a cart would become king. A peasant named Gordias drove his ox cart into the city, then his son Midas tied it to a post with an intricate knot. Some four hundred years later, Alexander the Great attempted to untie the knot while wintering at Gordium. When he could not find the end to the knot to unbind it, he sliced it in half with a stroke of his sword.
11. For example, the EU currently promotes standardized, sectoral baselines as opposed to project-specific baselines. Moves to introduce such a system would require a COP decision – the executive board alone does not have that power. The most recent attempt to introduce sectoral crediting was at COP15 in Copenhagen. The EU proposal was blocked by the Alliance of Small Island States. Alternative proposals or macro-level baselines using complex population calculations (such as the NSW scheme) seem to be preferable. Michaelowa (1999) argued that the credibility of emissions reductions against simple sectoral baselines without taking into account technological improvements would not be good enough for investors.
12. For example, Indian and Chilean generation data is freely available on the Internet, however Chinese grid emission factors are a heavily guarded state secret that 'even a multi-man month effort could not report' reliably (Michaelowa, 2005).
13. Baseline was defined as a 'scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity'. Three principal approaches to

defining a baseline were provided: (a) Existing actual or historical emissions, as applicable; (b) emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; and (c) emissions of the 'average emissions of similar projects undertaken in the previous five years, in similar ... circumstances, and whose performance is among the top 20 per cent of their category' (UNFCCC, 2001).

14. Axel Michaelowa has served on this, as well as operating a consultancy of CDM Project Development services.
15. After some refinement, the three most common additionality criteria have been incorporated into a 'consolidated additionality tool', which operates as the *de facto* standard (Michaelowa, 2009). These three elements are:

    Barrier analysis requires the demonstration that barriers exist that would prevent the proposed project from being carried out if the project activity was not registered as a CDM activity.

    The investment analysis requiring the demonstration that the proposed project activity is economically or financially less attractive than at least one other credible alternative.

    Common practice analysis. Common practice analysis requires an assessment of the extent to which the proposed project type (e.g., technology or practice) has already been deployed in the relevant sector and region.

16. AM0001 Methodology: Incineration of HFC-23 Waste Streams http://cdm.unfccc.int/UserManagement/FileStorage/0TRNGTH2M00EKXXJ924MUXOOUJ115V
17. On the inclusion of Hazelwood, see (Passey et al., 2007; Passey et al., 2008). I thank John Kaye for this analogy.
18. ACM0013, 'New grid connected fossil fuel fired power plants using a less GHG intensive technology' approved in September 2007.
19. The CDM executive board suspended all coal project methodologies in 2011 due to issues with additionality tests.
20. Over 5 million supply-side energy efficiency credits have been issued as of February 2015; most of these are single to combined cycle gas conversions (Fennhan, 2015).
21. http://www.internationalrivers.org/node/348 (accessed 15 May 2010).
22. For example the German-based NGO *CDM Watch* submitted formal objections to the validation of the Zhejiang Guodian Beilun Ultra-supercritical Power Project, which comprises two 1,000MW plants in China. The CDM Watch submission points out that the relevant section of the Zhejiang PDD lists 'the distribution of 92 questionnaires with a 100 per cent response rate (all approving the project) and a meeting with 20 unnamed persons (who also fully approved the project) as the entirety of the public participation process.

Conclusion: Beyond 8%: Resituating Emissions Trading

1. Is Europe's new climate target a walk in the park? http://www.sandbag.org.uk/blog/2014/oct/28/europes-new-climate-target-walk-park/ (accessed 30 October 2014).
2. See: http://www.clivespash.org/OrwellianGuidetoCarbonETS.pdf
3. Quoted here http://dpannell.fnas.uwa.edu.au/pd/pd0162.htm

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