Carbon markets and the production of climate change

Appropriating, commodifying and capitalising nature

Gareth Bryant

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Abstract

This thesis evaluates the efficacy of carbon markets by assessing the impacts of the EU ETS and its links with the Kyoto Protocol's flexibility mechanisms, the CDM and JI, on the socio-ecological, economic and political dimensions of climate change. The analysis of the relationship between the causes of climate change and the pollution movements, financial practices and policy debates that constitute these markets is developed by progressively introducing Marxist conceptions of the appropriation, commodification and capitalisation of nature, which organises the thesis in to three parts. The first part develops a critical understanding of the social relations, institutions and actors that produce climate change by appropriating carbon in capitalist economies. Mapping the organisation of capital and carbon to create a database of companies in the EU ETS reveals a concentration and centralisation of emissions among a relatively small number of publicly and privately owned corporations and large-scale power and manufacturing plants. The second part considers the processes that equalise differentiated relationships between installations and emissions, and offset projects and emissions reductions, in commodity form. Case studies of carbon allowance and credit networks associated with energy utilities RWE and E.ON illustrate the potential for the largest polluters to exploit unevenness in the production of climate change by trading transformative for marginal climate actions. The final part examines dynamics of accumulation and contestation in carbon markets in terms of the extent to which the capitalisation of carbon can support the expanded reproduction of capitalism. The crisis of the carbon market accumulation strategy and consolidation of the EU ETS in contestation over its reform are explained as outcomes of the contradictions faced by states in managing marketised environmental policy. Overall, the thesis argues that the EU ETS and its links with the Kyoto mechanisms have worked to entrench the production of climate change, necessitating a more efficacious and democratic approach to climate policy that directly targets the biggest corporate and state polluters.

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1 – Introduction

'Put a price on carbon'

In September 2014, UN Secretary-General Ban Ki-moon convened a summit in New York aimed at rebooting global progress on climate action. The summit brought together heads of national states, CEOs of large corporations, representatives from big non-government environmental organisations and leaders of multilateral institutions. The goal was to encourage actors in public and private sectors to make new commitments on climate change. Carbon markets were propelled to the top of this agenda by a World Bank campaign to 'put a price on carbon', words that were projected on the UN General Assembly headquarters on the Sunday night before the summit began.

One of the key outcomes of the summit was a series of statements organised by the World Bank and backed by 73 countries, 22 sub-national governments and over 1,000 corporations and investors committing to the expansion of carbon pricing initiatives. The governments that supported the World Bank's (2014c) statement to work "towards the long-term objective of a carbon price applied throughout the global economy" represented a significant show of international support for the development of carbon markets. They covered the majority of global emissions and economic activity and included significant polluters such as China, Germany, Russia, South Africa, Mexico, the United Kingdom, Indonesia, Italy and France. The conspicuous absence of other carbon-intensive economies, including Canada, the United States, Japan and Australia, from the supporters list was a reminder that a complete global agreement on carbon markets and other forms of carbon pricing, such as taxation, remained elusive. Still, support for the statement was forthcoming from the governments of major polluting cities, states and provinces within non-supportive countries, including Alberta, California and Tokyo. The list of corporations pledging support for carbon pricing also demonstrated the appeal of the market-based approach across industries. They included, for example, energy giant E.ON, cement producer Holcim, food and beverage company Nestlé, financial institution Deutsche Bank and big accounting firm PricewaterhouseCoopers (World Bank, 2014d).

Yet, the content of the World Bank's carbon pricing statement was a far cry from the state of actually existing carbon markets. In emphasising the necessity of carbon pricing for keeping temperature increases to below 2 degrees Celsius, the statement referred to the promising experience of carbon markets that had already been rolled out in different parts of the world. The statement proclaimed that "the momentum is growing. Pricing carbon is inevitable if we are to produce a package of effective and cost-efficient policies to support scaled up mitigation" (World Bank, 2014c). The notion that carbon markets represent the foundation upon which to build momentum for further climate action stood in stark contrast to the direction of carbon prices in the two largest carbon markets implemented to date: the European Union Emissions Trading System (EU ETS) and the UN's Clean Development Mechanism (CDM). On the day of the UN summit, 23 September 2014, the year-end price for European Union Allowances (EUAs), the carbon unit of the EU ETS, was €5.67, down from highs of over €30 in the early years of the scheme. The price of carbon credits produced in the CDM, known as Certified Emission Reductions (CERs), was sitting at close to zero, at €0.13, down from previous highs of over €20 (Intercontinental Exchange, 2014). While the proximate cause of the low carbon price has been the pervasive over-allocation of allowances and the economic crisis-induced downturn in production, the price crash reflects deeper socio-ecological, economic and political troubles in carbon markets. These can be illustrated with the gaps between the reasons given by E.ON, Deutsche Bank, and the German government for supporting the World Bank's carbon pricing initiative, and their actual experiences in the EU ETS and CDM.

First, the case of German electricity utility E.ON points towards a disjuncture between the climate mitigation rationale, and socio-ecological performance, of carbon markets. The World Bank places carbon pricing at the centre of efforts to "redirect investment commensurate with the scale of the climate challenge" (World Bank, 2014c). This was echoed by E.ON, which explained its support for the World Bank's statement by arguing that carbon pricing "is absolutely essential if we are to do our part to help transform the world's energy systems...Without the price on carbon, it is difficult for companies to make investment decisions and therefore impedes investments in climate-friendly technologies" (World Bank, 2014a). But, E.ON's CEO, Johannes Teyssen, who is also president of Europe's electricity industry lobby EURELECTRIC, has publicly stated that the EU ETS has failed to shift investment patterns in a more sustainable direction. In 2012 he declared, "let's talk real: the ETS is bust, it's dead…Does the price give any signal for new investments? No. None…I don't know a single person in the world that would invest a dime based on ETS signals" (Krukowska, 2012).

Second, the World Bank's strategy of garnering support for carbon markets from corporations which are not major polluters, such as Deutsche Bank, is symptomatic of the appeal of carbon markets in harnessing the power of finance to reduce emissions and creating new economic opportunities at the same time. Indeed, the World Bank statement reports that a growing number of companies around the world "use carbon pricing as a tool to manage the risks and opportunities to their current operations and future profitability" from climate change (World Bank, 2014c). The convergence of climate action and business opportunity was reflected in Deutsche Bank's statement that supporting the initiative was part of an "increasing effort to apply [Deutsche Bank's] financial expertise to environmental sustainability issues" (Deutsche Bank, 2014). Yet, Deutsche Bank's prior efforts to do just that in the EU ETS have been mired in controversy and financial loss. In 2012, Deutsche Bank's offices were raided, management board members investigated, staff arrested and trading partners jailed. Rather than creating price signals that could coordinate cost effective emissions reductions, Deutsche Bank had become entangled in fraudulent trading practices designed to profit from inter-country discrepancies in tax rules (Taylor, 2012). Independently from the investigation, Deutsche Bank closed its main carbon trading operations in the City of London in early 2013 in response to the evaporation of legitimate sources of profits in the depressed carbon market (Cripps, 2013).

Third, the flexibility of carbon markets underpins notions that the market-based approach has a unique capacity to generate political consensus on climate policy between governments that are reluctant to actively manage a transition to a clean economy. The World Bank statement refers to the way carbon markets can adapt to "each country's different circumstances and priorities" at the same time as fostering "greater international cooperation" between countries (World Bank, 2014c). In a speech broadcasted at the summit, German Chancellor Angela Merkel expressed this logic in explaining that for the German government "the benefits [of carbon markets] speak for themselves when, alongside an agreed CO_2 reduction roadmap, the market determines the carbon price on the basis of supply and demand" (Merkel, 2014). However, the year before, the benefits of the EU ETS were far from self-evident for elements of Merkel's government who opposed, and party members sitting in the European Parliament who helped defeat, a proposal designed to create the short-term conditions for a functioning European carbon price by temporarily withholding the auctioning of allowances. A compromise was eventually brokered and the measure was passed, but Merkel's decision to withhold support in the context of the German election casts doubt on the purported political advantages of carbon markets (Stonington, 2013).

The purpose of this thesis is to evaluate the efficacy of carbon markets in addressing climate change. The gaps between the rhetoric employed by E.ON, Deutsche Bank and the German government in support of carbon pricing, and their practical experience in the European and UN schemes, concern the socio-ecological, economic and political dimensions of carbon markets. These illustrations are indicative of the broad approach taken to evaluate the efficacy of carbon markets in this thesis, which understands the problem of climate change through these internally related dimensions. Thus, the thesis delivers on its objective by answering the following research question: do the EU ETS and its links with the Kyoto mechanisms address the socio-ecological, economic and political dimensions of climate change? Ten years on from the start of the EU ETS, the UN summit demonstrates that the market-based approach dominates thinking in global climate policy circles. An assessment of the rationale, organisation and operation of the instrument is therefore absolutely essential for the urgent task of responding to climate change. The third section of this introductory chapter reviews how orthodox and critical researchers have studied different aspects of carbon markets and the fourth outlines the particular approach of this thesis in more detail. Before moving to these concerns, the next section contextualises the empirical focus of the thesis with a short history and overview of carbon markets.

A short history and overview of carbon markets

The policy predecessor to carbon markets was sulphur dioxide trading in the US. From the 1970s, under significant influence from the emerging neoclassical-oriented environmental economics discipline, the Environmental Protection Authority began to introduce elements of emissions trading in its regulation of pollution (Lane, 2012). Growing support for the market-based approach vis-à-vis 'command and control' measures among sections of government, business and non-government environmental organisations resulted in amendments to the Clean Air Act in 1990 that established a nation-wide sulphur dioxide trading scheme. The scheme aimed to address acid rain problems by reducing sulphur dioxide emissions from fossil fuel-powered electricity generators by 50 per cent compared to 1980 levels. Its key innovation was that within the overall cap, emissions allowances allocated or auctioned to certain power plants could be traded to cover the pollution of other power plants. According to the orthodox economic theory, the ability to trade would enable the marginal price of a sulphur dioxide allowance, not the decisions of state regulators, to decide how the overall environmental goal would be met.

Dominant interpretations of the socio-ecological success of the sulphur dioxide trading scheme played an important role in international negotiations on climate change. Orthodox economic assessments of the scheme highlighted its achievements in lowering abatement costs compared with direct regulation, spurred by greater than anticipated cost reductions in low-sulphur coal and scrubber technologies that remove sulphur dioxide emissions (Schmalensee et al., 1998; Stavins, 1998). Orthodox economists argue that the omniscience of the price mechanism produced the most efficient combination of fuel and technological factors compared to anything that could have been mandated by governments (Burtraw et al., 2005: 268–70). However, studies have attributed fuel cost reductions to unrelated changes in the transport industry (Ellerman and Montero, 1998) and found a negative (Taylor et al., 2005: 370) or mixed (Popp, 2003: 658) relationship with technological innovation. The orthodox economic account is also undermined by a comparison with the approach taken to acid rain elsewhere. In Europe, more direct regulatory measures, such as emissions limits and technology standards, achieved greater sulphur dioxide emissions reductions than the US over the same period (Milieu et al., 2004; Vestreng et al., 2007). But this didn't stop the US government from using the purported success of its instrument to push for a market-based approach to achieving greenhouse gas emissions targets under the 1997 Kyoto Protocol.

US negotiators fruitfully used the story of the cost efficiency of sulphur dioxide trading to support its goal of “binding but flexible” commitments in the Kyoto Protocol (Grubb et al., 1999: 88–91). The US sought to counter the then opposition to market-based measures from many European negotiators by making the inclusion of trading instruments a condition for agreement on binding emissions reduction targets. Similarly, the US overturned opposition from developing countries through the transformation of a Brazilian proposal for a levy on developed countries for breaching binding targets into the CDM (Grubb et al., 1999: 94, 101–3). The CDM was one of three market-based mechanisms, alongside JI and Emissions Trading between countries, which were adopted as a result of these deliberations. All three mechanisms introduced flexibility in how emissions targets could be met (UNFCCC, 1997).

The CDM and JI follow the particular carbon market model known as ‘baseline and credit’. The instruments facilitate the development of individual projects, such as the construction of wind farms, the installation of energy efficient light bulbs or the destruction of potent industrial gases, which claim to reduce greenhouse gas emissions in different ways. The reduction claim is assessed according to the difference between actual greenhouse gas emissions and a baseline scenario of what would have occurred in the absence of the project. The difference is rewarded with an amount of carbon credits equal to the quantity of emissions reduced by the project. Carbon credits – CERs in the case of the CDM and Emission Reduction Units (ERUs) in the case of JI – can be sold to governments, and with the development of the EU ETS, individual companies. These state and corporate actors can then surrender the credits to meet their respective climate commitments, as an alternative to reducing their own emissions. The CDM and JI both follow this basic framework but are institutionally and geographically distinct, with separate UN governing bodies and different project locations. CDM projects must be located in countries that are not part of Annex I to the 1992 United Nations Framework Convention on Climate Change (UNFCCC). These are countries that don’t have emissions targets under Kyoto and are mostly developing. JI projects must be located in Annex I countries that do have Kyoto targets, including European, Anglosphere and ex-Soviet Union countries, as well as Japan (UNFCCC, 1997).

Despite US negotiators achieving almost everything that was on their agenda at the outset of negotiations, the US Senate never ratified the Kyoto Protocol and President George W. Bush withdrew Bill Clinton's executive support for it in 2001 (Grubb et al., 1999: 112; Meckling, 2011: 134–5). The success of the market-based agenda therefore failed to bring about global inter-governmental climate consensus. Nonetheless, the flexibility mechanisms remained as the foundational instruments of the Kyoto Protocol. The CDM and JI grew rapidly following the institutionalisation of their rules and procedures in the Marrakech Accords in 2001. By 1 September 2014, the CDM had 7,554 projects registered that had been issued with 1.48 billion CERs, representing emissions reductions totalling 1.48 billion tonnes of carbon dioxide-equivalent (tCO_2-e). JI was somewhat smaller, but still significant, with 604 projects that had been issued 850 million ERUs (Fenhann, 2014a, 2014b)

The growth in the Kyoto mechanisms was driven primarily by demand created by the link created between the CDM and JI and the EU ETS in 2004. This followed a dramatic post-Kyoto change in the centre of gravity for global carbon markets. In the aftermath of Kyoto, BP and Shell instituted internal carbon trading systems and the UK and Denmark implemented national-level schemes (Betsill and Hoffmann, 2011: 93). The EU then shifted from an ambivalent position to carbon market leaders by legislating, in 2003, what would become the world's largest international carbon market and the "cornerstone" of EU climate policy (European Commission, 2013e: 1; Wettestad, 2005).

The EU ETS, which started on 1 January 2005, operates differently to the CDM and JI as a 'cap and trade' carbon market. Rather than awarding carbon credits for emissions reductions, a quantity of carbon allowances (EUAs), each representing one tonne of CO_2-e, is created that is equal to an overall emissions level. Currently, emissions of CO_2, nitrous oxide (N_2O) and perfluorocarbons (PFCs) in certain sectors are covered and the cap is set at 21 per cent below 2005 levels by 2020. EUAs are distributed to more than 11,000 'installations' – generally power stations or manufacturing facilities – by governments through free allocation or auctioning, depending on specific country and industry circumstances. Installations are situated in all 28 EU member states, as well as Iceland, Liechtenstein and Norway, and are responsible for around 45 per cent of EU emissions. Industries including electricity generation and gas supply, oil refining, iron and steel, aluminium, cement, ceramics, paper, chemicals and aviation are covered. This geographical and sectoral coverage has evolved over three distinct phases: phase one, a 'trial' period from 2005 to 2007; phase two, coinciding with the Kyoto Protocol commitment period from 2008 to 2012; and a post-Kyoto third phase from 2013-2020 (European Commission, 2013e).

Crucially, like the sulphur dioxide scheme, carbon allowances can be traded between operators of installations. This allows some installations to pollute above levels represented by the quantity of allowances allocated to them or bought at auction, by purchasing additional allowances from the operators of other installations with excess allowances. Furthermore, since 2008, carbon credits from the CDM and JI, although with certain quantitative and qualitative restrictions, could be surrendered by EU ETS installations in lieu of carbon allowances. The link with the CDM and JI allows the overall EU ETS cap to be exceeded on the basis that an equivalent quantity of emissions is reduced by offset projects outside the cap. The economic logic informing both internal EU ETS trading, and external trading with the Kyoto mechanisms, is that different actors have different marginal abatement costs and that trading directs emissions reducing activities towards the least cost options, thus reaching the same overall emissions goal at lower aggregate costs to the economy (Tietenberg, 2006). There is, however, scant evidence that carbon price movements have been driven by abatement costs in practice (Koch et al., 2014). The European Commission (2013e: 2), which has the job of regulating the EU ETS, nonetheless describes the rationale of the instrument in these economic terms, stating:

> Emissions trading systems are among the most cost-effective tools for cutting greenhouse gas emissions…In contrast to traditional 'command and control' regulation, emissions trading harnesses market forces to find the cheapest ways of reducing emissions…By putting a price on carbon and thereby giving a financial value to each tonne of emissions saved, the EU ETS has placed climate change on the agenda of company boards across Europe.

The operation of trading within the EU ETS can be hypothetically illustrated with reference to some of the supporters of the World Bank's carbon pricing statement previously highlighted. Like most companies in the electricity industry, E.ON has faced a deficit of allowances following allocation. Conversely, like most companies in the cement industry, Swiss company Holcim has enjoyed a surplus of allowances.[1] A power plant installation owned by E.ON in the UK could therefore purchase allowances from a cement plant installation owned by Holcim in France to ensure EU ETS compliance. E.ON and Holcim could also, and indeed did, purchase and surrender offset credits to, respectively, close its allowance deficit or increase its allowance surplus (European Commission, 2013b). The credits may have been purchased from Nestlé, which hosts a CDM project at one of its cereal factories in Chile that earned CERs for switching its energy source from coal to gas (UNFCCC, 2015a). Trading between EU ETS operators and offset project developers involves other companies that are not regulated by the EU ETS but which provide services to regulated EU ETS companies and offset projects and/or participate for proprietary gain. Before winding down its carbon trading operations, Deutsche Bank was one such institution, facilitating the exchange of carbon allowances and credits between its clients as well as trading in its own right (Deutsche Bank, 2008). Similarly, PricewaterhouseCoopers is one of the main companies that has acted as a consultant in the design of individual CDM projects (Fenhann, 2014a).

Non-regulated corporate supporters of, and participants in, the EU ETS and Kyoto mechanisms are indicative of the new areas of economic activity generated by carbon markets. What can be called the carbon trading industry comprises carbon brokers, exchange platforms, emissions auditors, offset project developers, news services and law firms, among many others. Together these businesses combined to generate carbon trading activity with a nominal transaction value that grew from less than €1 billion at the onset of the EU ETS in 2005 to reach €92 billion in 2011 (Bloomberg New Energy Finance, 2012; World Bank, 2005). Almost all of this trading was associated with the EU ETS and Kyoto mechanisms, with EUA trading comprising 75 per cent of the total and

[1] Method for mapping companies with emissions and trading patterns is outlined in Chapter 3 and the Appendix.

CER/ERU trading making up another 18 per cent (Bloomberg New Energy Finance, 2013b). Since then, the crash in carbon prices has seen the rise in the transaction value of the global carbon market come to a halt. By 2013, it had more than halved to €40 billion, with the Kyoto segment of the market hit particularly hard; its €400 million value in 2013 represented only 2 per cent of the CER/ERU portion of the 2011 global peak (Bloomberg New Energy Finance, 2014).

Outside of the EU ETS and Kyoto mechanisms, growth in carbon markets has been below early expectations. Movements towards the adoption of a cap and trade system in the US came with predictions of a rise in the yearly value of the global carbon market to US$2 trillion (Kassenaar, 2009). Although it had the support of the US House of Representatives and President Obama, the main Waxman-Markey piece of legislation put forward to establish such as scheme failed to pass the US Senate in 2009-10 (Meckling, 2011: 61–2). By 2013, other carbon markets had been implemented or scheduled for implementation in five countries (Australia, New Zealand, Kazakhstan, Switzerland and South Korea), seven Chinese provinces or cities (Beijing, Tianjin, Shanghai, Hubei, Chongqing, Guangdong, Shenzhen), two Canadian provinces (Alberta, Quebec), the nine north-eastern US states that participate in the Regional Greenhouse Gas Initiative (RGGI), California and three Japanese cities (Tokyo, Kyoto, Saitama) (World Bank, 2014b: 26; see also Betsill and Hoffmann, 2011). This steady, but not rapid, rollout of carbon markets globally had another setback in 2014, with a new conservative government repealing, after just two years of operation, Australia's fixed carbon price, which was set to become a fully-fledged carbon market linked with the EU ETS, following an election campaign fought heavily on a pledge to "axe the tax" (Ranson and Stavins, 2015: 7; The Economist, 2014).

In sum, underneath the confidence in the socio-ecological necessity of, the political momentum towards, and the economic weight behind, carbon markets that was on display at the UN climate summit, the policy approach has a more chequered history. The socio-ecological results of the "grand policy experiment" of sulphur dioxide trading, which supported the initial adoption of carbon markets, are questionable (Stavins, 1998). Global climate politics remains fractious close to two decades after the Kyoto Protocol cemented carbon trading as "the only game in town" (Jotzo, 2005: 81).

Meanwhile, the "new carbon economy" that has been built around carbon markets is faltering (Boyd et al., 2011). With many notable exceptions, aspects of these disconnections have been reproduced in the orthodox economic, political economy and post-structuralist literature on carbon markets.

Mainstream and critical literature

Orthodox economics

Orthodox economic analyses of the EU ETS have concentrated on quantifying the impact of the instrument on greenhouse gas emission levels. While acknowledging problems in design and implementation, these studies have consistently concluded that the scheme has successfully induced greenhouse gas emission reductions in a cost efficient manner, mirroring justifications given by elite corporate and state actors on the efficacy of carbon markets. To date, most of the research published has focused on the first phase of the scheme, due to the lag in data availability and the additional difficulties for the environmental economic method posed by the economic crisis affecting Europe since 2008 (Laing et al., 2014).

In the most wide-ranging analysis of the first phase of the scheme, Ellerman et al. (2010: 167) calculate that the EU ETS was responsible for the reduction of 120-300 million tCO_2-e, with a best estimate of 210 million tonnes, between 2005 and 2007, a 3 per cent drop. Anderson and Maria (2011: 97) come up with similar results, finding aggregate net abatement of 174 million tonnes in phase one. More limited evidence of reductions in emissions growth and emissions intensity in the first two years of phase II (2008-9), disaggregated from the crisis-induced drop in emissions, has also been presented (Abrell et al., 2011: 9; Egenhofer et al., 2011: 11). Ellerman et al. (2010: 164, 168) argue that when the EU ETS was introduced in 2005 emissions dropped "perceptibly" and that the "most obvious" cause of this was the incorporation of the carbon price into production decisions. Focusing on the first two years of the scheme, Ellerman and Buchner (2008: 283) conclude: "given the observed increase in real output for the EU ETS sectors, it is unlikely that CO_2 emissions from the installations included in the scheme would have declined in the absence of the EU ETS."

Ellerman and Buchner's conclusion is revealing of the method employed by orthodox economists to calculate emissions reductions. In a similar vein to the logic governing the issuance of carbon credits from offset projects, orthodox economists measure emissions reductions in relative rather than absolute terms. This is achieved by producing counterfactual scenarios measuring emissions levels in the absence of carbon markets and comparing this to emissions levels with carbon markets, whether modelled or observed. For example, absolute emissions data show that emissions by installations covered by the EU ETS increased in both 2006 and 2007 (European Environment Agency, 2013a). But Ellerman et al. (2010: 164) claim that abatement continued through these years because the EU ETS placed increases in absolute emissions "on a lower trajectory" than business as usual.

The emissions reductions achieved by the EU ETS were also found to be cost efficient. Ellerman et al. (2010: 243, 258) provide a basic estimate of total abatement costs at €0.9 billion per year for 2005 and 2006, which they describe as "imperceptible" and "lost in the noise" of other costs facing EU ETS actors. In the orthodox economic literature, carbon markets are assumed to be cost efficient provided transaction costs are low and other distorting influences minimised. Transaction costs were examined for Irish companies participating in the EU ETS. The study found that "overall the costs are so low that they are unlikely to impose a drag on firms' overall performance" (Jaraitė et al., 2010: 201). Inefficiencies, however, have been found, not in the operation of the EU ETS itself, but in its interaction with other policies. Böhringer (2014: 10–11) argues that national carbon taxes, renewable energy and energy efficiency obligations, and the separation between EU ETS and non-EU ETS sectors, have directed emissions reduction efforts away from least cost opportunities, leading to suboptimal outcomes.

Orthodox economic studies differ in the extent to which they take into account economic activity, baseline efficiency improvements, weather changes, energy prices, wider policy settings and other factors, as well as how the factors are taken into account, such as using econometric modelling, ex-post data or surveys. The inevitable exclusion of key variables and the imperfect inclusion of others results in methods of deduction with varying levels of reliability. Delarue, Ellerman et al. (2008: 36), focusing on the electricity sector, acknowledge empirical complexity, but ultimately defer to economic theory, in concluding that "all else being equal, a higher [carbon] price will result in more abatement…[but] the amount of abatement will depend as much upon load and fuel price relationships as it will upon the price of CO_2." Nonetheless, orthodox economic analyses do produce valuable insights into the relationship between short-term price movements and emissions levels.

It is the interpretation of this relationship, where quantitative emissions reductions are presented as evidence for the efficacy of carbon markets provided they are efficient, that is more problematic. Most of the emissions reductions found by orthodox economists in the first phase of the EU ETS were a result of 'fuel switching' between existing coal and natural gas power generation capacity (Ellerman et al., 2010: 192). At any point in time, the combination of gas and coal fuel prices, the energy efficiency of different plants, consumer demand, load capacity, as well as other regulatory and infrastructure factors, determine what mix of fuel is used to generate and sell electricity into the grid. The introduction of a carbon price adds an additional factor to these determinations, which can bring forward the point in the 'merit order' between fuels at which gas-fired power becomes relatively more profitable than coal-fired power (Ellerman et al., 2010: 174). Fuel switching is said to have been the cost efficient option in phase one of the EU ETS because it "was the easiest to achieve and required the least lead time" (Ellerman et al., 2010: 192).

One study calculated 88 and 59 million tonnes of emissions reductions from this form of fuel switching in 2005 and 2006, respectively (Delarue, Voorspools, et al., 2008: 45). The estimate was revised downwards in a subsequent paper to 35 million tonnes in 2005 and 20 million tonnes in 2006 because the original model overestimated the level of coal-fired power generation in the counterfactual, underscoring the need to approach the precise calculations of orthodox economists with caution (Delarue, Ellerman, et al., 2008: 30, 37). Ellerman et al. (2010: 181) then settled on an estimate between the two figures at 55-97 million tonnes for 2005-06, before the first carbon price crash of 2007 that nullified any fuel switching effect.

Whatever the exact figure, the central place of fuel switching in mainstream economic accounts of the emissions reductions engendered by the EU ETS challenges the conclusions in the literature on the efficacy of carbon markets in addressing climate change. Leaving aside scientific evidence that the lower emissions created by burning gas rather than coal to generate electricity may be cancelled out by increased methane leakage in upstream sectors, which are not covered by the EU ETS (Wigley, 2011), fuel switching does not effectively address climate change when viewed outside the narrow emission reduction paradigm of orthodox economics. This is underscored by the case of the UK, where the bulk of fuel switching was found to have occurred (Delarue, Ellerman, et al., 2008: 34; Delarue, Voorspools, et al., 2008: 43; Ellerman et al., 2010: 181). The relative nature of emissions reductions is made clear by acknowledgements that fuel switching in the UK occurred alongside a 12 per cent increase in coal-fired generation from 2005 to 2006, but that the carbon price prevented an even greater increase (Ellerman et al., 2010: 183; McGuinness and Ellerman, 2008: 11). More fundamentally, the reason for the concentration of fuel switching in the UK was because substantial pre-existing coal-fired generation and gas-fired generation capacity provided significant scope to do so (Delarue, Ellerman, et al., 2008: 36).

Hence, emission reductions from fuel switching were achieved by working within prior patterns of carbon-intensive investment in the energy sector, risking further lock-in of the place of fossil fuels in the economy (see Unruh, 2000). What made fuel switching the cost efficient option for reducing emissions – the fact it did not require significant and new long-term investments – also made it an ineffective way of addressing climate change. An alternative framework is needed to analyse the socio-ecological impacts of carbon markets that moves beyond the marginal abatement cost curve by recognising the variegated impacts of particular efforts to reduce emissions in their historical and geographical context. This requires a more critical understanding of the underlying social causes of climate change.

Political economy

The political economy literature has contributed to the development of such a framework by understanding the operation of carbon markets in terms of the relationship between capitalist states and the accumulation of capital. Indeed, the literature conceptualises carbon markets as a state-sanctioned accumulation strategy for capital. This perspective is summed up by Bumpus and Liverman (2008: 142), who argue that "given the considerable profits to be made from trading in carbon reductions, offsetting and other profits from emission reduction can be seen as a form of 'accumulation by decarbonisation'." They nominate a number of different ways in which carbon markets support capital accumulation. On one hand, polluters may profit from passing on the costs of allowances allocated for free, selling surplus allowances and avoiding costly methods of reducing their own emissions. On the other, new carbon trading industries profit from extra revenue streams created by offset project status, fees charged by service providers involved in the monitoring, reporting and verification of emissions, and trading carbon allowances and credits and their derivative instruments in financial markets (Bumpus and Liverman, 2008: 141–3). With each, there is a key role for "state intervention to establish and regulate new markets and stabilise capital investments in nature" (Bumpus and Liverman, 2008: 145).

Together and separately, Newell and Paterson have delivered some of the most sustained political economic analysis of the role of the state in driving the carbon market accumulation strategy (Newell and Paterson, 1998, 2009, 2010; Paterson, 2001, 2010, 2012; Newell, 2008, 2012; see also Matthews and Paterson, 2005). This work is partly informed by the Marxist notion that capitalist states face twin imperatives of accumulation and legitimation (e.g. Hay, 1994; O'Connor, 1973). The accumulation imperative arises from "the centrality of the state in the process of capital accumulation, on which the continued existence of a capitalist order is dependent" (Newell and Paterson, 1998: 691). But states also need to legitimise their role in supporting the reproduction of capitalism in civil society through democratic institutions. Contestation over this role often results in tensions for states between competing accumulation and legitimation imperatives (Paterson, 2010: 348–9). Carbon markets offered states the prospect of satisfying both imperatives. First, states could respond to democratic pressure for action on climate change, and in a way that aligned with prevailing ideological preoccupations with the efficiency of markets. Second, carbon markets could avoid direct confrontation with existing patterns of fossil fuel-based accumulation while promoting new sites of accumulation for other actors (Newell and Paterson, 2010: 26–8).

Powerful financial actors contemporaneously echoed expectations of profit-making opportunities. The head of environmental markets at Barclays Capital, for example, predicted carbon would overtake oil as "the world's biggest commodity market, and it could become the world's biggest market over all" (Kanter, 2007). Similarly the head of emissions trading at Merrill Lynch anticipated carbon markets could rival the world's largest derivatives markets, as "one of the fasting-growing markets ever, with volumes comparable to credit derivatives inside of a decade" (Kanter, 2007). For Paterson (2012: 83), the significance of such statements is that they represent the potential for the "formation of a 'winning' political coalition favouring [greenhouse gas] emissions reductions." While not downplaying the roadblocks presented by ongoing struggles between polluting interests, states and citizens, Newell and Paterson (2010: 10) emphasise the importance of the finance industry as "a powerful constituency that benefits from climate-change policy, which is crucial politically." Given the balance of political economic forces in global capitalism, this informs a pragmatic assessment of carbon markets as "rather appealing" (Newell and Paterson, 2010: 10).

Other researchers working within political economy have instead argued that the very accumulation dynamics underpinning carbon markets undermine the potential of the policy instrument to decarbonise the economy (Bachram, 2004; Bitter, 2011; Böhm and Dabhi, 2011; Bond, 2012; Pearse and Böhm, 2015; Rosewarne, 2010; Vlachou, 2014; Vlachou and Konstantinidis, 2010). Böhm et al. (2012: 1630) also view carbon markets "as the latest incarnation of an ongoing process of commodification and capitalist expansion." The state remains a key institutional force in this account, which draws attention not only to the role of governments in the global North seeking flexibility, but also the advocacy of the governments of Brazil, Russia, India, China and South Africa (the 'BRICS'), which have hosted a large proportion of CDM and JI projects (Böhm et al., 2012: 1632). However, rather than charting a climate-friendly accumulation pathway, carbon markets are understood as reinforcing the existing organisation of the fossil fuel-dependent global economy and thus contributing "to some perverse social, economic and environmental trends unfolding within the current regime of capitalist accumulation" (Böhm et al., 2012: 1630).

Similarly Lohmann (2011a: 86–7, 90) emphasises the "especially close state corporate relationship" that underpins carbon markets as "creating and stabilising new areas for capitalist activity." Lohmann (2010, 2011a, 2011b) links this conception to ineffective climate outcomes by describing a series of complex equations that underpin carbon markets. While the equations are necessary for carbon markets to function and profits to be made, Lohmann argues each act of commensuration takes market-based climate policy one step away from the fundamental climate problem at hand. The economic interests supported by problematic carbon equations inform a less optimistic view of the political potential of pro-carbon market coalitions due to the "endemic rent-seeking that makes their regulators so vulnerable to capture" (Lohmann, 2010: 241–2). The arguments of carbon market critics in political economy are supported by scathing case studies and critiques from social movements and activist researchers (Bachram, 2004; Böhm and Dabhi, 2009; Ghosh and Sahu, 2011; Gilbertson and Reyes, 2009; Lohmann, 2006; Smith, 2007).

In contrast to the political economy literature, the recent economic woes of the EU ETS and the CDM suggest states have been reluctant to support, or faced difficulties in supporting, a new carbon market accumulation strategy. At least nine other major financial institutions based in the City of London have joined Deutsche Bank in closing or scaling back their carbon trading operations including Barclays, JP Morgan, Morgan Stanley and UBS (Straw and Platt, 2013: 25). Value write downs from CDM project assets left stranded by the crash in CER prices have been estimated at US$66 billion, which has hit developing country investors particularly hard and had negative flow on effects on consultancy and other service providers leaving the market (Philp, 2013; World Bank, 2014b: 98–9).

Impacts on configurations of capital are critically important for evaluating the efficacy of carbon markets in responding to the economic dimensions of climate change. Yet, limited attention has been given to the current crisis of carbon markets (Bracking, 2015; Ervine, 2013; Felli, 2014; Reyes, 2011). Given the central place of accumulation dynamics in divergent political economic assessments of the efficacy of carbon markets, a reconsideration of the relationship between states, carbon markets and accumulation is essential.

Post-structuralism

A variety of post-structuralist literature, much of it drawing on governmentality, actor-network and performativity perspectives, has analysed the prospects of carbon markets for responding to climate change from a very different starting point. In this literature, the focus is less on states and accumulation and more on uncovering the “technologies, techniques, practices and rules” that construct carbon markets (Lovell and Liverman, 2010: 256). The attention to the details of particular aspects of carbon markets that this focus entails is evident in the range of topics tackled. For example, the technical features that allow carbon markets to function, such as the global warming potentials that commensurate different greenhouse gases (Lohmann, 2009; Lövbrand and Stripple, 2011; MacKenzie, 2009), how accountants record carbon credits and allowances in company balance sheets (Lovell, 2013; Lovell et al., 2013) and the economic modelling underpinning allowance allocation formulas (MacKenzie, 2008), have been heavily scrutinised. The activities and conventions of carbon market actors have also been studied in terms of the translation of financial market trading practices and architectures (Knox-Hayes, 2009, 2010) and the emotional and ethical logics of carbon traders (Descheneau and Paterson, 2011; Paterson and Stripple, 2012). The regulation of carbon markets has been further considered with respect to the changing modes of climate governance involving state and non-state actors (Lövbrand and Stripple, 2012; Methmann, 2013) and the performance of economic theory in debates over policy design (Blok, 2011; Callon, 2009). Lastly, differences between and within carbon markets have been highlighted by focusing on the social and discursive formation of particular carbon currencies (Descheneau, 2012; Stephan, 2012) and the specific technologies of individual offset projects (Bumpus, 2011; Lohmann, 2005; Lovell and Liverman, 2010).

These contributions have illuminated the mechanics of commodification in carbon markets. This has been achieved by expanding the field of analysis beyond conventional parliamentary arenas and moving into the idiosyncratic worlds of accounting standards boards, bureaucratic offices of regulators and scientific climate models. An introduction to a special issue of the journal *Environmental Politics*, in which some of this research was published, describes its aim in the following way:

> By drawing on a broader understanding of the political and hence locating politics not just in the policy process leading up to the decision to implement a carbon market, the contributions to this volume show how these markets themselves are fundamentally political (Stephan and Paterson, 2012: 557).

Conclusions drawn in the post-structuralist literature on the political implications of the approach are particularly significant for the assessment of the impact of carbon markets on the political dimensions of climate change in this thesis.

Some post-structuralist researchers have found encouragement in the prospects for carbon market reform in their examinations of the details of the variegated forms of market construction. Lovell and Liverman (2010: 255) frame their approach as an alternative to literature that is "polarised, either for or against offsetting, often on principles and values rather than detailed empirical investigation or a careful assessment of different types of offsets." The importance of this perspective in making judgements on the potential efficacy of carbon markets is underscored by MacKenzie (2009: 441) who insists, using a similar line of enquiry, that "whether or not carbon markets are environmentally and economically effective depends on such specifics." Further, the details of carbon markets, "as experimental objects," are understood to be in a constant state of flux, and therefore not inherently flawed, but amenable to improvement (Callon, 2009: 538). This position is articulated by Lövbrand and Stripple (2011: 198) in their conclusion that "by drawing attention to the mundane accounting practices that currently make the climate governable, we find that they are more contingent, recent and modifiable than most of us may think." MacKenzie (2009: 452) brings this argument to its logical conclusion in urging researchers and activists to adopt a "politics of market design."

As flagged, MacKenzie (2008: 175–6) has used the issue of allowance allocation formulas to empirically explore what he terms the "technopolitics" of carbon markets. The key issue was whether techno-political efforts directed towards changing the basis on which the European Commission assessed the allocation plans of national governments could address the over-allocation problems that contributed to the steep phase one carbon price crash. Indeed, the changes, which incorporated verified emissions data and more rigorous modelling of future emissions, gave the European Commission grounds to demand reduced phase two allocation levels for 23 countries (MacKenzie, 2008: 171–4). However, MacKenzie's (2008: 175) pre-recession hope that this change could "prove to have been effective in ending over-allocation" was misplaced; an overall surplus of around 2 billion allowances had accumulated by the end of the second phase (European Commission, 2014k: 8).

The particular issue of allocation raises questions about existing post-structuralist analyses of the political implications of carbon markets. The preoccupation with locating politics in the functioning of carbon markets has rarely been extended to an analysis of the difference carbon markets make to climate politics, however defined. The danger of avoiding such an analysis is to reproduce ideas on the inexorable political momentum of carbon markets. This is evident in Mackenzie's (2009: 452) pronouncement that "carbon markets are here to stay," which stems from an appreciation of the barriers to campaigning for alternative policy options that is not applied to the politics of market design, such as changing the allocation formula. Further, issues such as the allowance surplus have seen the details and technicalities of carbon markets increasingly become the focal point of more conventional climate politics. The European Commission, for example, has conducted public consultations on mechanisms to adjust the supply of allowances to market conditions, as well as on issues such as whether carbon allowances should be classified as financial instruments and how the risk of carbon leakage, which determines free allocation and compensation levels, should be calculated (European Commission, 2014e). Each has been preceded, and followed, by political contestation between government agencies, corporations and NGOs on the issue. It is within these formal political processes that progress towards reform on allocation in the EU ETS has recently been reversed, with previously legislated plans to end free allocation by 2027 scuttled by energy-intensive industry in negotiations over the EU's post-2020 climate and energy framework (General Secretariat of the Council, 2014).

The impacts of carbon markets on political processes that are both implicated in climate change, and are critical to addressing it, are as important for evaluating the efficacy of carbon markets as their pollution and financial effects. Stripple and Paterson (2012), in arguing that the "virtue" attached to the link between carbon markets as climate change serves to diminish opposition to the policy, is one of the few examples in the post-structuralist literature where this concern is addressed. The limitations in MacKenzie's treatment of allocation demonstrates the need for further empirical analyses of political struggles over the design of the EU ETS that account for the way the institutionalisation of carbon markets enables and constrains climate politics.

Outline of thesis and chapter summary

The discrepancies between arguments made in existing mainstream and critical literature on carbon markets and evidence from the EU ETS and the CDM/JI indicate the need for three further research questions to structure the response to this thesis' central research question on the efficacy of carbon markets in addressing climate change. First, from the shortcomings of orthodox economic analyses of cost effective emissions reductions comes the question: do carbon markets challenge the social causes of greenhouse gas emissions? A second question emerges from the need to understand why the carbon market accumulation strategy – theorised by political economists as moulding the climate outcomes of the approach – is collapsing: what is the relationship between carbon markets, states and the accumulation of capital? Lastly, weak outcomes from formal debates over specific market designs beg a third question, which engages with post-structuralist perspectives on the prospects of carbon market reform: how has the adoption of carbon markets shaped political contestation over climate change? This thesis develops its analysis of carbon markets through these questions by progressively introducing Marxist conceptions of the appropriation, commodification and capitalisation of nature and relating them to the notion of 'carbon'. The appropriation, commodification and capitalisation of carbon organise, in turn, the thesis into three parts, with the latter conceptions being built out of the former.

Part One of the thesis develops a critical understanding of the social causes of climate change as criteria on which the first sub-question can be addressed. The focus is on the social relations, institutions and actors that engender the appropriation of carbon in capitalist economies in general and within the regulatory scope of the EU ETS in particular.

Chapter Two begins with a critique of the ontological conceptions of nature in orthodox economic notions of carbon pollution as ‘externality’ and ‘reciprocal cost’. It argues, drawing on Smith (2008) and Harvey (1996), that the shortcomings of orthodox economic assessments of the EU ETS are a product of an external-universal ‘ideology of nature’ that functions to displace and disperse the social causes of climate change. Recognising this, the chapter moves towards developing an alternative conceptual framework out of Smith, Harvey and Swyngedouw’s (1999) work on the ‘production of nature’, which locates the causes of climate change in the appropriation of carbon that occurs within patterns of fossil fuel-intensive capital accumulation. Benton’s (1989) and O’Connor’s (1998) formulations on nature as a ‘condition of production’, which highlight the material constitution of value and the structural position of the state, are then introduced to further explain why and how capitalism produces climate change in an unintentional and uncontrolled manner.

Chapter Three maps the relationship between the organisation of capital and the appropriation of carbon in the EU ETS in order to develop a more historically and geographically specific understanding of the production of climate change. The empirical basis for this analysis is the construction of a database of companies participating in the EU ETS by matching installation and ownership-level information. The exercise reveals that a relatively small number of publicly and privately owned corporations and large-scale power plants and factories are responsible for a disproportionately large share of emissions. Using historical evidence on the embedding of technological dependence on fossil fuels, the institutionalisation of the corporation and the recent state-mediated consolidation of the European electricity industry, the chapter argues the capitalist production of climate change is an uneven process constituted by the concentration and centralisation of capital and emissions.

Part Two of the thesis examines the socio-ecological impacts of the commodification of carbon in the EU ETS and its links with the Kyoto mechanisms. Following the analysis in Part One, the question of whether carbon markets challenge the social causes of climate change becomes a question of the effects of the EU ETS and CDM/JI on the uneven organisation of the capitalist appropriation of carbon. Its two chapters build on the conceptual and empirical content of Part One by theorising carbon commodities as particular representations of the appropriation of carbon and using the two corporations responsible for the greatest proportion of emissions as case studies.

Chapter Four is primarily concerned with the commodification of carbon within the EU ETS. The chapter revisits the initial adoption of the EU ETS by examining the positions articulated by big polluting corporations in favour of carbon markets, which reveal interests in exploiting unevenness in the production of climate change. It then considers, referring to the broader 'commodification of nature' literature, how the European carbon commodity equalises certain variegated relationships between 'installations' and 'emissions'. A case study of the trading relationships of the EU ETS' biggest polluting corporation, RWE, is assembled by reconstructing EUA flows between installations to explore the socio-ecological outcomes of commodification in practice. By illustrating the uneven forms of carbon appropriation substituted in the process of carbon trading, the chapter argues that the EU ETS supports the maintenance of the existing organisation of emissions.

Chapter Five's point of departure in its treatment of the Kyoto mechanisms is how they overcome limits to exploiting internal differentiation in the EU ETS. The significance of the link with the CDM and JI is understood in terms of the potential for polluting capital to overcome these limits through the commodification of relationships between 'projects' and 'emission reductions' that fall outside the EU ETS. The chapter argues that the Kyoto mechanisms represent an external 'fix' that greatly extends, through time and space, the commodification of uneven social relations with nature. A case study of E.ON's carbon credit trading strategy, achieved by tracing CER and ERU flows from CDM and JI projects to E.ON installations, provides a more complete picture of the way in which the EU ETS and Kyoto mechanisms combine to preserve, rather than challenge, patterns of carbon appropriation that are at the core of the capitalist production of climate change. The cost efficient emissions reductions seen by orthodox economists are therefore recast as socio-ecological inertia due to the switching of more marginal for more transformative climate actions.

Part Three of the thesis broadens the evaluation of the efficacy of the EU ETS and its links with the Kyoto mechanisms to consider their impact on the economic and political dimensions of climate change. Capitalist value relations are placed at the centre of the analysis of accumulation and contestation in carbon markets through the conception of the capitalisation of carbon. This again builds on the previous parts of the thesis by understanding capitalisation in terms of the extent to which value, underpinned by the appropriation of carbon, circulates in carbon commodities and becomes the basis for the expanded reproduction of capitalism.

Chapter Six reconsiders political economic arguments on carbon markets as accumulation strategy in light of the economic crisis facing the EU ETS and Kyoto mechanisms. It draws on literatures on financialisation, and value and nature, to chart the financial development of carbon markets from their inception, including changes in distributional dynamics, trading institutions and financial innovations. The chapter argues that diminishing profits from both the expropriation of carbon rents and the extension of financial activity are products of the reluctance of states to support an intensive accumulation strategy. This is attributed to contradictions between creating the conditions for the capitalisation of carbon and state support for the appropriation of carbon. However, the chapter also argues that the fundamental structure of the EU ETS contains the potential for a system of capitalised carbon to emerge, which, although representing an accumulation strategy that is sustainable in economic terms, imposes capitalist discipline that cements the most profitable uses of fossil fuels.

Chapter Seven surveys three recent episodes in the ongoing attempts to reform the EU ETS: qualitative restrictions on industrial gas offsets, backloading of allowance auctions and the 2030 climate and energy package. Following on from the discussion of the capitalisation of carbon in the previous chapter, each episode is understood, respectively, in terms of the reach, force and priority of capitalist value relations in organising the appropriation of carbon. It charts an active politics of carbon market design among industry groups, environmental organisations and state bodies over the course of the three debates. This contestation produced real, though varied and limited, reforms but also contributed to the consolidation of the EU ETS at the expense of the residualisation of alternative, non-carbon market measures. By injecting an appreciation of the tensions facing states in marketising the regulation of nature that is missing in post-structuralist accounts, the chapter argues that institutionalisation of carbon markets constrains, but does not completely foreclose, the development of much needed radical alternatives to carbon markets.

The Conclusion underscores the contributions, limitations and implications of the three major research themes that run through the thesis: conceptualising capitalist social relations with nature, understanding climate change and evaluating carbon markets. It synthesises the preceding chapters by arguing that the EU ETS and its links with the Kyoto mechanisms entrench the production of climate change by maintaining the organisation of polluting capital, threatening to intensify the capitalist value relations that drive carbon-intensive accumulation and working against more efficacious policy options. This informs an appeal for more a democratic and efficacious approach to climate policy that directly targets the biggest corporate and state polluters.

Part I: Appropriating carbon

2 – Capitalism, nature, climate change

Introduction

An evaluation of the efficacy of carbon markets first requires an understanding of the problem of climate change that the policy instrument is aiming to address. How climate change is understood shapes methods employed to analyse, and ultimate assessments of, carbon trading systems. This in turn influences normative positions on the design of, and choices between, competing market-based and alternative climate policies. The first part of this thesis is dedicated to developing a critical understanding of climate change that can underpin analysis of the implementation, operation and evolution of the EU ETS and its links with the Kyoto mechanisms in the second and third parts of the thesis. The purpose of developing a critical understanding of climate change is to provide the criteria necessary to judge the central research question of the thesis on the efficacy of carbon markets in addressing climate change. Following a critique of the shortcomings of the conception of climate change in orthodox economics, the chapter seeks to understand, at a relatively abstract level, the social relations, institutions and actors shaping the appropriation of carbon in capitalist economies. The next chapter then extends and applies the framework in the more concrete context of the particular corporate actors regulated by the EU ETS.

The Introduction argued that the focus of orthodox economic literature on relative emissions reductions and cost efficiency produces flawed assessments of the socio-ecological sustainability of actions induced by carbon markets. The first section of this chapter continues the engagement with orthodox economics because it is the approach that not only informs the most prominent assessments of the performance of the EU ETS, but also provides the economic rationale for the market-based response to climate change adopted by the EU and the UN. Specifically, the chapter examines the ontology of nature that underpins orthodox economic understandings of climate change and, in turn, flawed assessments of the EU ETS. This is traced back to the work of two of the economists that have been incredibly influential in shaping orthodox economic understandings of, and responses to, environmental problems: Pigou (1932) and Coase

(1960). Drawing on Smith (2008) and Harvey (1996), the section identifies marketised versions of external and universal conceptions of nature, respectively, in Pigou's understanding of pollution as an 'externality', and Coase's intervention on the 'reciprocity' of costs. The section argues assessments and policy prescriptions of orthodox economists are frustrated by the legacies of Pigou and Coase, which combine to form an economic 'ideology of nature' that serves to displace carbon pollution from its social causes and disperse social responsibility for addressing climate change.

The ontological roots of shortcomings of orthodox economics inform the need for a critical theoretical framework that doesn't treat nature as separate from, or the same as, society. The second section of the chapter develops such a framework out of Marxist conceptions of nature as 'socially produced' (Harvey, 1996; Smith, 2008; Swyngedouw, 1999). Climate change is broadly conceptualised through this theoretical lens as a product of capitalist social relations impelling the accumulation of capital through the use of fossil fuels. Other Marxist ideas are then introduced to further develop this understanding of climate change as the unintentional and uncontrolled capitalist production of nature. The work of Benton (1989) is used to analyse the 'intentional structure' of fossil fuel-intensive production processes, which shows climate change is the consequence of dependence on, and indifference to, the materiality of natural conditions by capitalist actors. O'Connor's (1998) theorisation of the natural conditions of production as being outside capitalist control is then used to consider how state institutions regulate, and environment organisations and industry bodies contest, the production of climate change. The chapter concludes by explaining how the focus on the appropriation of carbon that emerges from this understanding of the capitalist production of climate change provides a basis for analysing the efficacy of the EU ETS and its links with the Kyoto mechanisms in terms of the commodification and capitalisation of carbon.

Orthodox economics and the ideology of nature

Pigou and the external conception of nature

Orthodox economists, operating within the oeuvre of neoclassical economics, conceptualise carbon pollution as an 'externality'. The foundation of this conception is Pigou's (1932) contribution to welfare economics, a sub-discipline of neoclassical economics. The study of economic welfare, according to Pigou (1932: 10–14), is concerned with changes in human satisfaction and dissatisfaction that can be measured in monetary terms. Pigou's analysis is methodologically individualist in viewing the operation of the economy through the lens of the rational behaviour of individual agents. This behaviour is analysed by employing a marginalist method that focuses on incremental changes in prices and quantities in order to measure and manage 'private' and 'social' economic welfare. Private welfare, or "marginal private net product," is made up of "physical things or objective services" that directly benefit the owners of resources (Pigou, 1932: 134–5). Social welfare, or "marginal social net product," extends the consideration of the costs and benefits of goods and services to their indirect effects on all economic actors, including those that are not directly a party to the economic transactions yielding private welfare (Pigou, 1932: 134–5).

Pigou's work focuses on situations where the two measures diverge in either direction, creating both positive and negative externalities. The latter, where private welfare is greater than social welfare, is most pertinent for the study of climate change. Negative externalities arise when:

> One person A, in the course of rendering some service, for which payment is made, to a second person R, incidentally also renders disservices to other persons (not producers of like services), of such a sort that payment cannot be exacted from the benefited parties or compensation enforced on behalf of the injured parties (Pigou, 1932: 183).

Negative impacts of economic activity are therefore defined in terms of the relationship of affected parties to economic exchange. "Uncompensated or uncharged effects" occur when the private benefits accruing to parties involved in economic exchange impose social costs on others that are external to the exchange relationship (Pigou, 1932: 191). This divergence in private and social welfare is a problem, according to Pigou (1932:

172), because “self-interest will not, therefore, tend to make the national dividend a maximum,” and overall resource allocation will be suboptimal.

Pigou (1932: 27–8) exhibits an appreciation of the application of welfare economics to environmental issues by incorporating the “tendency to[wards] wasteful exploitation of Nature’s gifts” in the treatment of divergences in private and social welfare. Examples of environmental externalities, which continue to be relevant in the contemporary context, include:

> Over-hasty exploitation of the best coal seams by methods that cover up and render unworkable for ever worse, but still valuable, seams; fishing operations so conducted as to disregard breeding seasons, thus threatening certain species of fish with extinction; farming operations so conducted as to exhaust the fertility of the soil.

The examples show, however, that the negative impacts of economic practices on coal, fish and soil are not accounted for in terms of socio-ecological considerations such as the disruption of ecosystems, threats to livelihoods, or loss of environmental amenity. The latter is explicitly ruled to be outside the definition of economic welfare in the absence of a “charge for viewing scenery” (Pigou, 1932: 33). Instead, impacts are conceptualised in terms of “injury to the sum total of economic satisfaction” compared with alternative allocations of mining, fishing and farming resources (Pigou, 1932: 28).

The Pigouvian framework feeds into environmental economic approaches that diagnose the cause of climate change as unpriced carbon pollution. The result of this negative externality is market failure: the private benefits of current levels of carbon pollution are below the social costs of climate change because such costs are not reflected in the price of carbon-intensive goods and services. The most prominent expression of this was the UK government’s *Stern Review*, which attempted to quantify the loss of economic welfare from the divergence between private and social welfare from carbon emissions in terms of global economic output. The report famously asserts that “unpriced emissions” of greenhouse gases have created a “market failure on the greatest scale the world has seen" that will reduce global GDP by 5-10 per cent per year by the year 2100 (Stern, 2007: 25, 35).

The central focus on unpriced carbon pollution, owing to the historical influence of welfare economics, also underpins the preoccupation with relative emissions reductions in the orthodox economic assessments of carbon markets surveyed in the Introduction (Anderson and Maria, 2011; Ellerman et al., 2010). The primary concern with how much, rather than how, emissions are reduced reflects an understanding of climate change as a quantitative pollution problem, measured in terms of the deviation from the optimal level of pollution as determined by the price system. That the problem is unpriced emissions is clear in the distinctive method employed for calculating relative emissions reductions. Once other known factors that influence emissions levels are taken into account, the assumption is that any reduction in actual emissions from the counterfactual scenario is due to the influence of the carbon price on participants in the EU ETS (Ellerman and Buchner, 2008: 283).

The focus of the *Stern Review* and mainstream EU ETS literature on unpriced emissions illustrates the effect of the Pigouvian framework on orthodox economics. It displaces enquiry into the causes of climate change away from the particular practices generating carbon pollution and towards the malfunctioning price system. Furthermore, unpriced emissions are only a problem in aggregate market terms, which displaces analysis of the particular and uneven impacts of polluting practices. This is the framework that allows practices such as fuel switching from coal to gas in countries with fossil-fuel intensive energy systems to be registered as cost efficient emissions reductions. Pigou therefore provides a way for orthodox economics to thoroughly excavate any social content from understandings of the causes and impacts of climate change. This amounts to an economic version of the pervasive tendency in Western thought to understand nature as external from society.

Critical Marxist geographers, including Smith (2008) and Harvey (1996), among other social theorists (e.g. Williams, 1983), have investigated the historical development of the external conception of nature in a number of fields, including science and the arts. Some of the clearest depictions of the external conception of nature in arts and literature come from poetic and visual portrayals of wilderness in the US in the nineteenth and early twentieth centuries. At first, the wilderness was represented as the opposite of civilisation and something to be conquered, which then gave way to something to be preserved, sanitised and appreciated (Smith, 2008: 20–1). Both ways, wilderness was something that was apart from society and therefore amenable to management by society for certain ends. As Smith (2008: 28) argues, "whether hostile or not, the fact of the externality of nature is enough to legitimate nature's subjugation." A similar line of thought can be identified in science. The externality of nature is evident in Francis Bacon's instrumental approach to the 'mastery' of nature and Isaac Newton's method of observing phenomena outside its social context (Harvey, 1996: 121–3; Smith, 2008: 13–15). In a similar vein to the implications of wilderness as external nature, Harvey (1996: 122) argues that the "separation between 'I' and 'it' that grounds modern scientific enquiry into the processes at work 'in nature'" became attached to the Enlightenment project aimed at the "domination of nature."

External nature is commonly presented as that which is "pristine, God-given, autonomous" (Smith, 2008: 11). The external conception of an autonomous nature in scientific enquiry is evident in climate models that consider the "physical properties of [greenhouse gases] in isolation from the surrounding social relations that produced them and give them meaning" (Demeritt, 2001b: 316). Orthodox economics gives this external conception of nature a marketised inflection by comprehending the external character of pollution in relation to the price system. In this framework, carbon pollution is only a problem when it results in market failure. The problem is external to the actors, relationships and institutions that generate greenhouse gas emissions because it resides in an autonomous, self-regulating market. The external carbon pollution problem is nonetheless naturalised through subsumption of markets and nature by Pigou (1932: xii), who states that markets distribute resources according to their "natural tendencies."

The external conception of climate change paves the way for policies that attempt to address carbon pollution separately from its social context. Like the examples from arts and literature that aim to dominate or subjugate nature, the aim is to perfect the natural tendencies of markets. Pigou (1932: 224) became well-known for advocating for the taxation of externalities by states to achieve this goal, reasoning that:

> For every industry in which the value of the marginal social net product is less than that of the marginal private net product, there will be certain rates of tax, the imposition of which by the State would increase the size of the national dividend and increase economic welfare; and one rate of tax, which would have the optimum effect in this respect.

Locating environmental problems at the point of exchange therefore translates to proposals to address environmental problems at the point of exchange, through carbon pricing initiatives aimed at correcting the price system to optimise the use of external nature for economic ends.

Coase and the universal conception of nature

Some governments around the world have responded to climate change with Pigouvian-style carbon taxes at domestic and sub-domestic levels (World Bank, 2014b: 16–17). However, the major international climate policies that are the focus of this thesis depart from Pigou's proposal for states to directly adjust market prices to efficient levels. As discussed in the Introduction, carbon markets such as the EU ETS and the Kyoto mechanisms ostensibly allow the market to find least cost abatement options by allowing the trading of carbon credits and allowances to set carbon prices. This shift can be traced back to Coase's (1960) influential critique of the Pigouvian tradition, which provides the theoretical basis for market solutions to environment problems.

The overall objective of Coase's paper *The problem of social cost,* for which he was awarded the economics equivalent of the Nobel Prize, is broadly in line with Pigou's goal of managing externalities to achieve an efficient allocation of resources. For example, Coase (1960: 15) asserts that "the economic problem in all cases of harmful effects is how to maximise the value of production." However, Coase's paper strongly objects firstly to Pigou's method of analysing externalities and secondly to Pigou's proposals for addressing them.

Coase refines the analysis of externalities by dispensing of the Pigouvian concern with distribution of costs between private and social spheres and instead treating all costs in reciprocal terms. The argument is illustrated with a simple example of two neighbouring farmers, where the cattle owned by one stray onto and damage the crops owned by the other:

> It is true that there would be no crop damage without the cattle. It is equally true that there would be no crop damage without the crops…If we are to discuss the problem in terms of causation, both parties cause the damage. If we are to attain an optimum allocation of resources, it is therefore desirable that both parties should take the harmful effect (the nuisance) into account in deciding on their course of action (Coase, 1960: 13).

By making costs reciprocal the analysis of the 'harmful effects' of externalities is extended beyond costs imposed on third parties to the costs incurred by parties in addressing that harm. The cause of the problem does not simply reside in markets that are external from polluters; all parties, polluters and non-polluters alike, are made responsible.

The reciprocity of costs transforms the economic reasoning behind efforts to correct market failure to a problem of "avoid[ing] the more serious harm" (Coase, 1960: 2). As Coase (1960: 27) explains:

> The problem which we face in dealing with actions which have harmful effects is not simply one of restraining those responsible for them. What has to be decided is whether the gain from preventing the harm is greater than the loss which would be suffered elsewhere as a result of stopping the action which produces the harm.

Government regulation is put forward as an example where it "will no doubt be commonly the case" that the costs of addressing a harm will outweigh the benefits

(Coase, 1960: 18). Similarly, Pigouvian taxation is also viewed as potentially inefficient because governments cannot know the price that will generate optimal outcomes.

While Pigou favoured government intervention on prices because the externality occurred outside of contractual relationships, the Coasian alternative is to expand the sphere of such relationships by extending property rights to all resources. Popularised as the 'Coase theorem', the argument is that given clearly defined property rights, trade between private actors will achieve an efficient allocation of resources and maximise the total value of production. In the example above, this means finding the combination of crops and cattle that generates the highest value output. Provided there are no transaction costs, the Coase theorem holds that trading will create the optimal outcome independent of the initial distribution of rights (Coase, 1960: 15). A central motivation of studies of transaction costs in the EU ETS is to test whether Coase's condition for a cost efficient outcome has been met in order to sidestep debates over allowance allocation patterns (Jaraitė et al., 2010; Reguant and Ellerman, 2008: 14; Abrell et al., 2011: 10).

The broader significance of Coase on these orthodox economic analyses of the EU ETS is, however, in the influence of the notion that costs are reciprocal in crafting a particular understanding of efficiency that serves to limit social action. This is evident in Coase's (1960: 34) argument, contra Pigou, that "from an economic point of view, a situation in which there is 'uncompensated damage'…is not necessarily undesirable." Here Coase introduces important caveats for taking action against externalities, because desirability is wholly defined in terms of the optimal level of pollution that will maximise the value of production. The logic underpins the cost-benefit analysis conducted by Stern (2007: 299), who dismisses the possibility of reducing global atmospheric concentrations of greenhouse gases to anything below 450 parts per million – levels the IPCC (2014: 21) says are "likely" to be needed to prevent global warming of over 2 degrees Celsius – as "prohibitively expensive." It also underpins criticisms in the literature surveyed that emissions reductions generated outside the EU ETS framework, such as by renewable energy and energy efficiency policy, were effectively reducing emissions by too much, and in the wrong ways, because the actions did not represent least cost abatement (Böhringer, 2014: 10–11).

The particular understanding of efficiency that emerges from the Coasian notion of the reciprocity of social costs introduces a contradictory but politically useful counterpart to the external conception of nature: universal nature. Universal nature is closely linked with notions of human nature, viewing human behaviour and society more generally as part of nature and inescapably subject to unmanageable natural laws (Smith, 2008: 12). The historical instances from science and the arts that illustrated ideas of external nature also tend to exhibit the universal conception of nature. For example, abstracting scientific enquiry from a particular social context allows the findings to be presented as universal laws operating across all social contexts. This is a universal conception of nature that continues to support biological and chemical explanations of social phenomena (Smith, 2008: 16–17). In the case of the arts, romantic painters and poets in the US developed ideas of nature that differed from the external nature of wilderness. They instead depicted landscapes in ways that emphasised universal truths, whether from God or some other essential source, that emanate from nature (Harvey, 1996: 128; Smith, 2008: 22–3). The consequence of the universal conception is not the domination of nature, but rather submission to nature. Universalising capitalism in this way limits social action because "capitalism is natural; to fight it is to fight human nature" (Smith, 2008: 29).

Like external nature, a universal conception of nature is evident in the scientific construction of climate change, where climate models not only externalise the greenhouse gases from their social context, but also "universalise the objects of their knowledge ontologically. Physical sciences represent [greenhouse gases] in terms of certain objective and immutable physical properties" (Demeritt, 2001b: 313). This also feeds into orthodox economic approaches through the similarly universal properties given to the costs of climate change in Coase's marketised version of the universal conception of nature. Like Pigou, Coase treats pollution as the natural outcome of market processes. Unlike Pigou, for Coase, markets are not something that can be unproblematically adjusted by social institutions such as the state. The reciprocity of costs means that states are not treated as separate from natural market processes and therefore able to actively manage them. Instead, all social actors, including states, are part of and subject to the universal laws of markets. Social action to restrict or shape markets, such as by giving favourable policy treatment to renewable energy, therefore tends to impose costs that work against, rather than promote, the efficient allocation of resources and the maximum value of production, which is the natural outcome. The role of states is therefore limited to creating the conditions for market optimisation to occur through the extension and protection of easily tradeable property rights.

The economic ideology of nature

Combined, Pigou and Coase provide the theoretical basis for an economic version of what Smith termed the 'ideology of nature'. In harbouring both external and universal conceptions of nature, the ideology of nature is somewhat contradictory because society is both separate from, and part of, nature (Smith, 2008: 11–12). However, these contradictory positions also complement each other politically because, as Harvey (1996: 149) argues, the external and universal conceptions of nature function as two sides of "a pendulum between cornucopian optimism and triumphalism at one pole and unrelieved pessimism…of our powers to escape from the clutches of naturally imposed limits…at the other pole." The institutionalisation of real-world market-based environmental policies required further work by economists including Dales (2002 [1968]), Crocker (1966), and Montgomery (1972) (Tietenberg, 2006: 3–5). But the orthodox economic logic of carbon markets remains anchored in the formulations of Pigou and Coase, which represent each side of Harvey's pendulum.

On one side of the coin, Pigou's understanding of the cause of climate change as unpriced emissions externalises responsibility to market exchange. This external conception of nature anchors the optimistic side of the pendulum by encouraging market-based policy solutions in the confidence that externalities can be managed without fundamentally changing existing social structures. Orthodox economic assessments of those policies, based on the same ontology of nature, reproduce this rationale for carbon markets by quantifying relative emissions reductions in a socially undifferentiated manner. On the other side of the coin, Coase's universal conception of nature, based on the reciprocity of costs, universalises the cause of climate change to any non-optimising economic actors. This disperses responsibility for addressing climate change to where it is least cost while placing an effective natural limit on any social action on climate change that does not maximise the value of production, anchoring the pessimistic side of the pendulum by cautioning against market intervention. Again, orthodox economic assessments of climate policies reinforce this logic with narrow concerns about economic efficiency rather than broader socio-ecological impacts.

The economic ideology of nature deprives the orthodox economic framework of the critical understanding of climate change needed to assess the efficacy of carbon markets. Identifying this as the methodological source of the shortcomings of mainstream assessments of the EU ETS is useful for the objective of this chapter for two reasons. First, it underscores the need for an alternative conception of the nature of climate change. Second, it illuminates the ontological difficulties inherent in the external and universal conceptions of nature that must be overcome in any such framework.

The production of climate change

The production of nature

The notion of the 'production of nature', developed by Smith, Harvey and others operating within the historical materialist tradition, such as Swyngedouw (1999), offers an alternative framework that is built upon an ontological position of the "prior dissolution" of society and nature as "coherent entities" (Harvey, 1996: 140). Instead, society and nature are understood as "intertwined in perpetually changing ways in the production processes of both society and the physical environment" (Swyngedouw, 1999: 445). The approach challenges the ideology of nature by emphasising that nature is not separate from or the same as society; it is "socially produced" (Smith, 2006: 28) as a hybrid form of "socionature" (Swyngedouw, 1999: 446) or "created ecosystem" (Harvey, 1996: 186). The changing climate can therefore be viewed as "historical nature" which "embodies chemical, physical, social, economic, political and cultural processes in highly contradictory but inseparable manners" (Swyngedouw, 1999: 447).

Critical enquiry into the causes of, and responses to, climate change is directed towards these processes by the production of nature framework. From a Marxist perspective, the production of nature by the various processes identified by Swyngedouw is related to the organisation of labour in the prevailing mode of production. Smith (2008: 50) follows Marx in understanding produced nature as a "differentiated unity." The unity between society and nature is actively made through labour processes that transform and retransform landscapes in ways that are guided by dominant social relations of production and reproduction. Produced nature is in turn internally differentiated by the unequal character of those social relations, as "created ecosystems tend to both instantiate and reflect, therefore, the social systems that gave rise to them" (Harvey, 1996: 185).

Smith (2008: 52) employs Marx's (1973: 101) method of "rising from the abstract to the concrete" to explore how axes of social differentiation in produced nature unfold at different levels of "logico-historical" abstraction. Beginning with production in general, then production for exchange and finally capitalist production, Smith highlights how class relations and social institutions at each level of abstraction regulate divisions of labour and nature as they become mediated by increasingly complex value determinations. At the level of production in general, labour transforms nature to produce use values necessary for the reproduction of material life (Smith, 2008: 53–5). With production for exchange, the relationship between production and reproduction is mediated by exchange value. This sees the use values produced through the transformation of nature alienated from labour as commodities and facilitated by institutions such as the market (Smith, 2008: 63).

Capitalist production – which brings the framework closer to the concrete dynamics driving the production of climate change – is characterised by an additional, specific form of social alienation that differentiates social relations with nature: the separation of workers not just from the commodities they produce, but from the very means to produce commodities and reproduce themselves (Smith, 2008: 69). This socio-ecological organisation of material life is the foundation for the generalisation of wage labour in production relations and the dominance of value, as measured by socially necessary labour time, in decisions over when, where and how labour and nature are profitably recombined (Burkett, 1999). Competition between capitalists means that "abstract determinations at the level of value are continually translated into concrete social activity in the relation with nature" with the aim of producing surplus value and expanding the accumulation of capital (Smith, 2008: 70). Smith (2008: 77) argues that these features have made capitalism historically distinctive because "for the first time human beings produce nature at a world scale."

Climate change exemplifies the production of nature at a world scale. Socially produced greenhouse gas emissions are transforming the systems that regulate climatic conditions globally. The magnitude of the social transformation of nature, including and beyond climate change, is also captured in more recent concepts such as the 'Anthropocene', which posits the emergence of a new human-centred geological epoch (see Castree, 2014). But the focus of the production of nature framework on capitalist social relations, actors and institutions reveals the underlying social drivers of climate change. The primary source of greenhouse gas emissions is the combustion of fossil fuels, including coal, gas and oil, in industrial production. Between 1750 and 2011, two-thirds carbon dioxide emissions – the most prevalent greenhouse gas in terms of atmospheric concentration – were from the combustion of fossil fuels. The other one-third primarily came from land use changes, such as deforestation (Stocker et al., 2013: 50, 56–7). From a production of nature perspective, the combustion of fossil fuels is driven by the dominance of the specifically capitalist form of value in organising social relations with nature.

Capital appropriates carbon through the combustion of fossil fuels in order to substantially increase the productivity of labour. The combustion of coal, oil and gas increases productivity in a number of ways, including by expanding the scale of production, providing spatial and temporal flexibility to the location and timing of production and improving the speed and scope of transportation systems (Altvater, 2006; Huber, 2009; Malm, 2013). Capitalist social relations demand constant improvements in the productivity of labour, such as those enabled by the combustion of fossil fuels, in order to increase the production of surplus value by reducing the labour time necessary for any given process of commodity production (Burkett, 1999: 71). The wide uses of fossil fuels across multiple commodity production processes, including electricity generation and heat, transportation and a range of manufacturing processes, such as cement, steel and aluminium production, leads Malm (2013: 51) to describe fossil fuels as "the general lever for surplus-value production." Economic dependence on fossil fuels is therefore a product of an economic system that measures value in the particular form of socially necessary labour time. This internal relationship between fossil fuels and capitalism is so strong that scholars have theorised the manifestation of "fossil capital" (Malm, 2013), the emergence of "fossil capitalism" (Altvater, 2006) and described capitalism itself as a "fossil fuel mode of production" (Huber, 2009: 113).

From the production of nature perspective, climate change is neither an external problem of unpriced pollution nor a universal problem of reciprocal costs. Increasing concentrations of greenhouse gases in the atmosphere are products of fossil fuel-intensive production processes that are integral to the social relations of capitalism. The crucial actors here are those with class interests in effectively replacing labour power in circuits of capital with greenhouse gases. The historical legacy of such decisions is reflected in the cumulative emissions from the combustion of fossil fuels and the production of cement, which releases process emissions from chemical reactions. Indeed, cumulative emissions are particularly concentrated in regions with the longest histories of advanced capitalist development. Between 1870 and 2013, 23 per cent of emissions from fossil fuels and cement originated in the 28 EU countries – internally skewed towards the wealthier states of Germany, the UK and France – just below the largest cumulative emitter, the US, which was responsible for 28 per cent of emissions over the same period (Baumert et al., 2005: 32; Le Quéré et al., 2014: 37).

There is strong scientific consensus that the increase in the global atmospheric concentration of carbon dioxide, which rose from 278 to 391 parts per million between 1750 and 2011, is resulting in consequences such as sea level rises, extreme weather events and species extinction, with deleterious, though unevenly distributed, effects on human capabilities (Edenhofer et al., 2014; Stocker et al., 2013: 50). Smith (2008: 87) accounts for the damaging impacts of capitalistically produced nature by stressing that "the production of nature should not be confused with control over nature." The domination of nature thesis was and is a real project with multiple strands, but its roots in the ideology of nature prevent it from representing actual capitalist social relations with nature, which are marked by a lack of capitalist control (Smith, 1996: 47). Conversely, the production of nature thesis, according to Smith (2006: 28) "not only assumes no such comprehensive domination but leaves radically open the ways in which social production can create accidental, unintended and even counter-effective results vis-à-vis nature." The production of climate change is therefore an uncontrolled, unintentional outcome of the accumulation of capital via the appropriation of carbon.

This Marxist understanding of climate change provides useful alternative criteria for evaluating the efficacy of carbon markets because the EU ETS and its links with the Kyoto mechanisms can be analysed with regard to the social relations, actors and institutions that produce the problem. The efficacy of carbon markets can therefore be evaluated not in terms of the cost efficiency of relative emissions reductions, but in terms of their impact on existing patterns of the appropriation of carbon in fossil fuel-intensive industries. Chapter Four and Chapter Five analyse the impacts of the trading of carbon allowances and credits in this manner.

However, the production of nature thesis – and particularly Smith's formulation – has been criticised for overstating the power of capitalism in dictating social relations with nature. There are two dimensions to the critique that have bearing on the utility of the framework in forming a critical understanding of climate change. First, the production of nature framework has been criticised for its relative downplaying of the materiality of nature vis-à-vis the juggernaut of capital. Second, it has been criticised for elevating capitalist production over the full gamut of social practices shaping nature.

The first part of the criticism of the production of nature approach is summed up by Bakker and Bridge (2006: 9), who argue that the determination to avoid an external conception of nature "by envisioning first nature 'transformed' via labour, ends up squeezing out any productive or generative role for ecological or biophysical processes" (see also Castree, 1995: 20–1; Guthman, 2011: 235). Smith (1996: 49) defends the thesis against charges of "anthropomorphism" by arguing it accurately captures contemporary capitalism's place "at the centre of nature." Further, care is taken to accord ongoing power to "non-human forces and processes," which is seen in the conclusion that produced nature (and space) are "both the product and the geographical *premise* of capitalist development" (Smith, 2008: 68, 206 emphasis added). However, the material difference produced nature makes – whether enabling, constraining or otherwise – to the accumulation of capital does require further elaboration in order to analyse the place of carbon markets within the relationship between capitalism and fossil fuels. The next part of this section introduces Benton's (1989) notion of the intentional structure of capitalist production as a means to conceptualise the materiality of produced nature in value terms, which extends Smith's contention that the capitalist production of nature is an 'unintended' process.

The second part of the criticism is that Smith's framework is insufficiently social in narrowly emphasising capitalist production "at the expense of other processes which simultaneously socialise nature" (Castree, 2001: 204; see also Braun, 2006: 201–2). Smith (1998: 275–6) has also countered that this kind of reading ignores the expansive social meaning of production articulated by Marx (1973: 99) as one moment, together with distribution, exchange and consumption, in the totality of capitalist social relations. The emphasis on the *production* of nature, Smith (1998: 274–5) argues, is a necessary alternative to the discursively-oriented social construction of nature literature (see Demeritt, 2002). Combined, these retorts include within the scope of analysis a role for processes such as political interventions outside the immediate sphere of production in actively making and remaking nature. Nonetheless, other perspectives are needed to better comprehend the role of actors and institutions in broader society in shaping the course of climate change. Hence, in addition to Benton, the next part of this section also draws on O'Connor's (1998) theorisation of the structural position of states in regulating natural conditions of production, which develops Smith's notion of the 'uncontrolled' production of nature.

The conditions of production

Both Benton and O'Connor develop in different ways Marx's notion of nature as a 'condition of production' in order to theorise the production of socio-ecological crisis. Marx (1976: 648) defined natural conditions as "(1) natural wealth in the means of subsistence, i.e. a fruitful soil, waters teeming with fish, etc., and (2) natural wealth in the instruments of labour, such as waterfalls, navigable rivers, wood, metal, coal, etc." Benton's focus is the second dimension, which defines natural conditions of production in relation to labour processes.

Specifically, Benton (1989: 66) understands natural conditions in terms of the relationship between the material properties of nature and the "intentional structure of the labour-process." The starting point for Benton is Marx's (1976: 290) conception of the transhistorical labour process, as:

> Purposeful activity aimed at the production of use-values. It is an appropriation of what exists in nature for the requirements of man. It is the universal condition for the metabolic interaction between man and nature, the everlasting nature-imposed condition of human existence.

At the heart of labour processes, at the level of production in general, is therefore an intentional structure geared towards the production of use values. However, Benton (1989: 64) is critical of Marx's understanding of how the materiality of nature both enables and constrains the realisation of the intentional structure of labour processes, arguing that "Marx under-represents the significance of non-manipulable natural conditions of labour-processes and over-represents the role of human intentional transformative powers vis-à-vis nature." The consequence of these tendencies, according to Benton (1989: 55), is the deprivation of "historical-materialist thought of the conceptual means to recognise and explain ecological crises."

Benton's characterisation of Marx's shortcomings has itself been challenged as a partial reading of Marx (Burkett, 1998: 120–5). Nonetheless, the focus on the conditions of production from the perspective of the intentional structure of labour processes reveals why capitalism is particularly susceptible to the production of socio-ecological crises such as climate change. As discussed above, under capitalist production, use value is made subordinate to exchange value by capitalist social relations that impel the extraction of surplus value from labour for profit. Benton (1989: 70) states this "value-maximising intentional structure must be superimposed upon, and predominate over, the intentional structure of production in its aspect as a utility-producing labour-process." As a result, the materiality of nature falls within the intentional structure of capitalist production only insofar as its particular material properties augment the accumulation of value.

The material properties of fossil fuels serve this purpose due to the particular value system of capitalism. Labour productivity increases from the combustion of fossil fuels have been so central to capitalist development because the material properties of coal, oil and gas are not wholly valued as products of wage labour (Burkett, 1999: 70). While wage labour is involved in the extraction, processing, transportation and combustion of fossil fuels, this follows geological processes that concentrate energy over millions of years (Clark and York, 2005: 402). The latter is "unpaid work" which assists the accumulation of capital by replacing living (workers) and dead (capital) labour in the production process (Burkett, 1999: 71; Moore, 2014c: 292). From a value-theoretical perspective, material properties of coal, oil and gas appear as a "free natural power of capital" (Marx, 1991: 879). In the context of capitalist production, the appropriation of carbon is the appropriation of the surplus value extracted in fossil-fuel intensive labour processes.

However, Benton (1989: 72–3) argues that the material properties that fall within the intentional structure of capitalist production "will be only a limited sub-set of the properties really possessed" by natural conditions. Fossil fuels exemplify this point, because the very material "further adventures" of combusted fossil fuels as greenhouse gases fall outside the intentional structure of capitalist production that drives the appropriation of carbon. As dissipated energy, the material properties of greenhouse gases are "extrinsic to the achievement of" producing surplus value in the capitalist production process in question, and as a result are "excluded or occluded by the forms of calculation available to economic agents" (Benton, 1989: 73, 84). Rather, the capacity of forests, oceans and other parts of the biosphere to absorb and circulate carbon is simply "presupposed" by the intentional structure of capitalist production (Benton, 1992: 59; Clark and York, 2005: 402). The combination of dependence on, but indifference to, these carbon cycling processes engenders the unintentional production of climate change, an example of what Benton (1989: 77) terms "naturally mediated unintended consequences" of capitalist production.

It is increasingly recognised that climate change will have a negative impact on capitalist interests located in industries as varied as insurance, energy and tourism

(Field et al., 2014: 71). Benton (1989: 81) posits that each mode of production "must be conceptualised in terms of its own peculiar limits and boundaries, and its own associated liabilities to generate environmental crises and environmentally related patterns of social conflict." The material constraints imposed by the transformed climate system are therefore not just a product of, but are also relative to, the value-maximising intentional structure of capitalist production.

Overall, Benton's conception on the intentional structure of labour processes allows a value-theoretical approach to the materiality of produced nature. The approach underpins an understanding of climate change as a product of the particular way capitalist social relations organise the appropriation of carbon. The focus on the material constitution of value in capitalism leads to a rather different diagnosis of the causes of climate change than the mainstream economic focus on the absence of prices and property rights. The efficacy of carbon markets in part hinges on the relationship between carbon prices, carbon allowance and credit trading, and the intentional structure of capitalist production. Chapter Six takes up this issue in its analysis of the disciplinary effects of carbon markets on the appropriation of carbon.

A range of actors and institutions also have bearing on the production of climate change that are not necessarily directly involved in carbon-intensive labour processes. O'Connor theorises these broader social aspects of natural conditions by focusing on the issue of capitalist control rather than intention. O'Connor's conception of control stems from a combination of Marx's notion of the conditions of production defined above and Polanyi's (1944) idea of land, labour power and money as 'fictitious commodities'. Polanyi (1944: 72–5) argues that capitalism is constituted by a paradox where markets depend on the commodification of land, labour power and money even though "none of them are produced for sale" and therefore are not, in his definition, true commodities. O'Connor (1998: 146) understands the significance of this fiction in Marxist value terms, as "nature's contribution to physical production independent of (or abstracted from) the quantity of labour time (or amount of capital) applied to production."

What the Polanyian perspective brings is a focus on the social institutions that both facilitate and restrict the fictitious commodification of nature (Polanyi, 1944: 76). For O'Connor (1998: 148):

> This agency can be no other than the capitalist state that produces these conditions and/or regulates access to, use of and exit from labourpower, land, raw material, and other markets for fictitious commodities which Marx called 'production conditions'.

The central place of the state in the production of nature is a corollary of capital's 'free' appropriation the conditions of production. That aspects of the productive forces of natural conditions are not wholly produced in the circuit of capital is critical to the production of surplus value by reducing labour time below the social average (Moore, 2010: 394). However, this also places natural conditions outside the sphere of capital's direct economic control. As a result, the state is required as the "relatively autonomous" institution that ensures the "politically guaranteed existence" of natural conditions in "the desired quantities and qualities at the right times and places" (O'Connor, 1998: 148–9). State regulation of the conditions of production underpins an expansive notion of the production of nature that conceives of natural conditions as "produced and reproduced (or made accessible) within definite property, legal and social relationships" (O'Connor, 1998: 148).

Capital's appropriation of fossil fuels in the accumulation process is mediated by states in a multitude of ways, including taxation arrangements, licencing of reserves, pollution regulation, state ownership, research and development funding, competition policy and infrastructure provision. The subsidy value of state actions in EU energy sectors was quantified at €34 billion in 2011 (Alberici et al., 2014: 34). Examples such as this, which illustrates the integral role of states in the production of climate change, lead O'Connor (1998: 155) to argue "it is clear that environmental destruction cannot be laid at the door of capital alone; the state is deeply implicated in the crisis of nature."

O'Connor (1998: 164–6) theorises socio-ecological crises of capitalism as the product of contradictions arising from capital's dependence on, but lack of control over, natural conditions. The tendency to materially impair its own natural conditions of production, O'Connor argues, manifests as increasing costs to capital that create barriers to further accumulation that, if sufficiently widespread, could generate economic crises of underproduction. The potential costs of the uncontrolled production of nature to capital provides the impetus for state responses that attempt to sustain accumulation by "developing more control of production conditions" (O'Connor, 1998: 167–8). The motif of control encourages a more critical engagement with the role of states instituting climate policy than the orthodox economic focus on the possibilities and pitfalls of correcting market failure. More important are issues such as in whose interests is control is exerted in favour of in carbon markets, and the particular form of, and limits to, control represented by market-based instruments.

The regulation of natural conditions is not without its own contradictions, which make total control a goal rather than reality for states. While supporting accumulation by securing access to, and use of, impaired natural conditions for capital is a function of capitalist states, O'Connor (1998: 155) insists that "a *functionalist* theory of the relationship between capital and its conditions [is] implausible" (emphasis added, see also O'Connor, 2001: 107–8). The structural position of states in relation to natural conditions bureaucratises and politicises the production of nature. It has been established that environmental conditions are inextricably linked to class struggle over the production and distribution of value. The bureaucratisation and politicisation of the conditions of production through state regulation tends to displace social contestation over this to the formal political sphere. Such struggles are not, however, completely reducible to class. O'Connor (1998: 155) stresses, recalling the first dimension of Marx's definition of the conditions of production as the means of subsistence, that the conditions of capitalist production are also "conditions of human life – and of life itself." For O'Connor (1998: 14–15), this aspect of the conditions of production provides a structural basis for contestation by environment movements.

Conflicting interests between and within different arms and levels of states, fractions of capital, as well as social movements, manifest in constant contestation over the goals and instruments of state regulation of the conditions of production. Decisions over the institution of environmental policies are always contingent on these bureaucratic and political factors, which "affect state production and/or regulation of the conditions of production in highly complicated, often unknown, and sometimes unknowable ways" (O'Connor, 1998: 153). Hence, the relationship of the EU ETS to the production of climate change is dependent on the agency and power of climate activists and environmental organisations, the bodies representing carbon-intensive and green industries, and heterogeneous state actors. This is the approach adopted in the analysis of the politics of EU ETS reform in Chapter Seven.

While Benton's and O'Connor's frameworks extend the production of nature framework by building on Smith's notions of intentionality and control, both have been criticised for reproducing a conception of nature that is external to society. Harvey (1996: 146–7), places Benton and O'Connor within a Marxist reversion to "ecoscarcity and natural limits" where nature is an "axiomatic limiting condition of human existence." This is explicated by Castree (2000: 20, 23), who argues that Benton and O'Connor's frameworks are founded, in different ways, upon notions of separate ecological and economic systems with their own organising principles. These are valid criticisms; both frameworks indeed have somewhat dualistic starting points. Benton criticises Marx's conception of labour processes at the level of production in general by ascribing a materially enabling and constraining force for natural conditions that is independent of the social relations of production (Burkett, 1998: 124). Likewise, O'Connor's framework is organised on the basis of a 'second' contradiction between capital and nature that is separate from the 'first' contradiction between capital and labour, which risks an exogenous conception of socio-ecological crisis (Altvater, 1993: 218–22; Burkett, 1999: 94–5; Foster, 2002: 13; Lebowitz, 1996; Vlachou, 1996).

However, the problematic starting points are largely rectified in both frameworks through their theorisation of the production of socio-ecological crisis under capitalism, which make them substantively compatible with the ontology underpinning the production of nature approach. First, Benton (1989: 78) makes it clear that it is "a specific social relation to a natural condition," not its independent properties, that materiality enables and constrains labour processes. Second, O'Connor (1998: 171) arrives at a position that treats the capital-nature contradiction as internally related to the capital-nature contradiction, in explicitly linking worsening environmental degradation to intensifying the exploitation of labour through "attempts to reduce production and circulation time." Thus, while it is important to acknowledge issues of methodological commensuration, these should not, as they have tended do to in the Marxist literature on nature, prevent careful theoretical connections and combinations being made between the likes of Smith, Harvey, Benton and O'Connor (Castree, 2008b: 139).

Issues have also been raised about O'Connor's theory regarding implications of socio-ecological crisis. The formulation is at times guilty of rather mechanistically positing a translation between materially impaired conditions of production and a cost-side crisis for capital when such costs have commonly been unevenly geographically distributed, displaced into the future and used as an opportunity for further profit (Burkett, 1999: 195–6; Castree, 2000: 20–1; Foster, 2002: 10–11; Harvey, 1996: 146; Rosewarne, 1997: 102). However, the political content of the second contradiction thesis tempers this reading. Costs to capital may arise if the use values of nature are sufficiently degraded *and/or* political contestation over environmental damage is sufficiently strong to create a barrier to accumulation via state regulation or the direct action of movements (O'Connor, 1998: 242; see also Prudham, 2003: 640; Rosewarne, 1997: 113; McCarthy, 2004: 335). The accounts of the development of the EU ETS in Chapter Four, and the CDM and JI in Chapter Five, demonstrate that it is the latter path that is most relevant to understanding the policies as responses to the production of climate change.

Conclusion

The conception of the appropriation of carbon developed in this chapter lays the groundwork for an understanding of climate change that can form the basis of an improved assessment of carbon markets compared to orthodox economics. The term 'carbon' is often utilised in the critical literature on carbon markets, such as in analyses of the constitution, governance and effects of the "new carbon economy" (Boyd et al., 2011). Bridge (2011: 822) notes that in this work, "the elemental moniker 'carbon' has stood in for carbon-dioxide equivalent, a fictitious molecular category through which several different greenhouse gases are made commensurable." In discussing the appropriation of carbon, the conceptual focus is instead on the place of hydrocarbons –

coal, gas and oil – in capitalist economies. Bridge's (2011: 822) assessment is that the existing literature often overlooks the "commonalities and connections" between this 'old' carbon economy of extracting, processing, transporting and combusting fossil fuels and the 'new' carbon economy of accounting for, and trading in, tCO_2-e. In its evaluation of the efficacy of the EU ETS and its links with the Kyoto mechanisms in Part Two and Part Three, this thesis reconstructs a conception of carbon as commodity and carbon as capital, out of, and in relation to, the appropriation of carbon.

The Marxist perspectives introduced in this chapter combine to create a broad conception of the appropriation of carbon that focuses on the social relations, actors and institutions producing climate change. This counters the externalisation and universalisation of the problem in the orthodox economic approach with an understanding of climate change as a consequence of patterns fossil fuel-intensive capital accumulation that have been central to European capitalism and the global capitalist social formation. Evaluating the efficacy of carbon markets in addressing climate change then becomes a question of whether the policy engenders a shift in the production of nature away from the capitalist appropriation of carbon and towards more socio-ecologically sustainable directions. Theorising nature as a condition of production highlights the political economic dimensions of this task. Any assessment of the prospect that markets may engender new, more sustainable forms of accumulation or be the subject of successful campaigns for reform – two pathways towards effective climate action nominated in the critical literature (MacKenzie, 2009; Newell and Paterson, 2010) – must contend with the close relationship between materiality of fossil fuels and capitalist value relations, and the institutional regulation of this relationship by capitalist states.

This chapter has only gone part of the way in developing the critical understanding of climate change needed to evaluate the efficacy of the EU ETS and its links with the Kyoto mechanisms. The empirical focus of the thesis requires an understanding of how the social relations, institutions and actors that produce climate change in capitalist economies organise concrete patterns of carbon appropriation in the historical and geographical context of the EU ETS. The next chapter turns its attention to the particular socio-spatial relations, state policies, and corporate actors involved in the production of climate change in the regulatory domain of the European carbon market.

3 – Capital and carbon in the EU ETS

Introduction

The unintentional and uncontrolled production of nature is a systemic feature of capitalism, but occurs through concrete historical and geographical processes (Swyngedouw, 1999: 446). Climate change is therefore a consequence of the socio-ecological organisation of capitalist production through the combustion of fossil fuels at particular times and in particular places. The aim of this chapter is to continue the development of a critical understanding of climate change by focusing on patterns of the appropriation of carbon in industries regulated by the EU ETS. Applying the previous chapter's conceptualisation of the relationship between capitalism and climate change to this context is needed to evaluate the efficacy of the EU ETS, not only in terms of its interaction with the capitalist social relations that underpin the production of climate change everywhere, but also the specific actors and institutions responsible for the EU's contribution to the problem.

A more detailed account of fossil fuel industries covered by the EU ETS becomes essential when the disconnect between the theoretical assumptions informing market-based policies and the structure of the main polluting industries in the EU ETS is considered. The orthodox economic framework that prescribes the extension of prices and property rights to carbon emissions posits the existence of a perfectly free market with multiple buyers and sellers as a necessary condition for efficient and optimal outcomes. However, production in Europe's electricity, steel, oil refining and cement industries, the four biggest polluting sectors in the EU ETS (see Appendix), is characterised by oligopoly structures where a small number large corporations are dominant (Domanico, 2007: 5067–8; Ecofys, 2009a: 1; Ecorys, 2008: 23; European Commission, 2010f: 35–6). It is these concrete industry structures, not idealised market models, that organise the appropriation of carbon, and through which carbon markets operate.

This chapter analyses historical and geographical patterns of the appropriation of carbon in industries regulated by the EU ETS by mapping the relationship between the organisation of capital and the organisation of emissions. The first section starts with an empirical exercise that matches data on EU ETS emissions and companies in order to create a database that allows analysis of relationships between installations and their owners. This shows that the distribution of emissions between installations and owners within the EU ETS reflects the market structures of Europe's fossil fuel-intensive industries; a relatively small number of large-scale power stations and manufacturing facilities, owned by a very small proportion of states and corporations, dominate the appropriation of carbon.

The next two sections employ the conceptual tools developed in the previous chapter in order to account for the uneven distribution of emissions in the EU ETS, moving from more abstract to more concrete levels of analysis. The second section outlines Marx's notion of the concentration and centralisation of capital, highlighting its social and spatial aspects. It then explores the historical role of technological dependence on fossil fuels and the institutionalisation of the corporation as conditions for the socio-spatial concentration and centralisation of capital, which has produced a related socio-spatial configuration of emissions. In both cases, the focus is primarily on the development of the electricity generation industry because it is the sector responsible for the most EU ETS emissions. The third section focuses specifically on the reorganisation of the seven largest polluting owners from the electricity industry in the EU ETS in the EU's energy liberalisation period. The role of public ownership, privatisation and competition policy highlights the central role of the state in shaping the production of climate change and provides background on some of the main corporate actors on which the assessment of the efficacy of the EU ETS in Part Two and Part Three of the thesis rests on.

Mapping the distribution of emissions

Matching installations with owners

The appropriation of carbon by actors covered by the EU ETS can be mapped using emissions data collected by market regulators. There is no direct translation between the data and the appropriation of value; emissions levels are mediated by factors such as the energy efficiency of different fuels and the specifics of the production process. Nevertheless, emissions data is a useful proxy of carbon appropriation in production processes involving the combustion of fossil fuels (broadly defined to include all oxidation processes including gasification) and other chemical reactions that are covered by the scheme (European Commission, 2010b: 8–12). EU authorities primarily present the data at the installation level because installations are the units with emissions reduction compliance requirements under the EU ETS Directive. Installation level data provides some important information, such as on the scale of pollution from individual factories and power plants. However, it is missing comprehensive information on the companies that own and control them. Ownership information is critical because companies are the institutions through which capital organises production, intervenes in climate politics and manages carbon allowance and credit portfolios.

To bridge this gap, a database of companies participating in the EU ETS has been constructed by matching available installation data with companies information in the online *Orbis* database, exported on 16 July 2014 (Bureau van Dijk, 2014). In total, the database includes 13,454 installations that are matched with 7,397 individual companies from *Orbis*. This accounts for 92 per cent of the 14,617 stationary installations that were registered as of 11 March 2014 and 99 per cent of 2005-12 verified emissions (European Commission, 2014d). It is therefore an almost complete sample of current owners of installations responsible for historical emissions in the first two phases of the EU ETS. The Appendix at the end of this thesis outlines the sources used and explains the method employed for creating the companies database. The tables and accompanying discussion in the Appendix also provide further breakdowns of the coverage of the companies database according to the country, size, activity and sector of matched installations, compared to the EU ETS as a whole.[2]

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[2] Another project by researchers at the European University Institute in Florence conducted a similar project at the same time this database was constructed, matching 13,217 installations using a like method (Jaraitė et al., 2013). The project differs from this work because the focus is on historical ownership of installations during phase one of the EU ETS between 2005 and 2007, whereas this matching process was concerned with the most current ownership information.

The companies database provides an empirical basis for analysing patterns of carbon appropriation in the EU ETS according to relationships between installations and the companies that own them. It excludes aviation installations, which have been the topic of legal proceedings that have prevented the full planned participation of the sector. In this thesis, all analysis of these relationships is drawn from the companies database, unless otherwise noted. This section highlights four aspects of the relationships between installations and owners: ultimate owners of installations, ultimate owners of emissions, size of installations and company ownership type. In order to maintain a consistent sample across each of these measures, due to gaps in emissions and ownership data, a subset of the companies database is used in this section and throughout the thesis that excludes a small proportion of installations. The 814 installations that had zero verified emissions between 2005 and 2012 because they entered the scheme from 2013 onwards (as revealed by their permit entry date) were excluded, as complete emissions data was only available to 2012. More importantly, as 2012 marked the final year of the second phase of the EU ETS and the Kyoto commitment period, it represents a significant point at which to contain an evaluation of the socio-ecological outcomes of the policy. Of the remaining matched installations, the 1,702 with insufficient shareholder information in *Orbis*, designated with a "U" (unknown) or no independence indicator in the database*,* were also excluded. This leaves 10,938 matched installations. As such, the analysis is based on 79 per cent installations registered, and 94 per cent of emissions released, in the EU ETS between 2005 and 2012.

Ultimate owners of EU ETS installations

The 11,000-plus installations covered by the EU ETS is often presented as evidence of the vast scope of the instrument as "the first – and still by far the biggest – international system for trading greenhouse gas emission allowances" (European Commission, 2013e). Mapping relationships between installations in terms of their common ownership looks beneath this presentation to reveal the EU ETS market is dominated by a smaller group of corporate and state actors. The 10,938 installations registered before 2013 are directly owned by 7,003 individual companies. This means on average, each matched company owns about one-and-a-half installations. These 7,003 companies have 3,587 ultimate owners, which raises the average to around three installations per ultimate ownership group. Unless otherwise noted, ultimate ownership in this thesis is set at the high level of an ownership path of at least 50.01 per cent, which is the most conservative definition of a controlling stake.

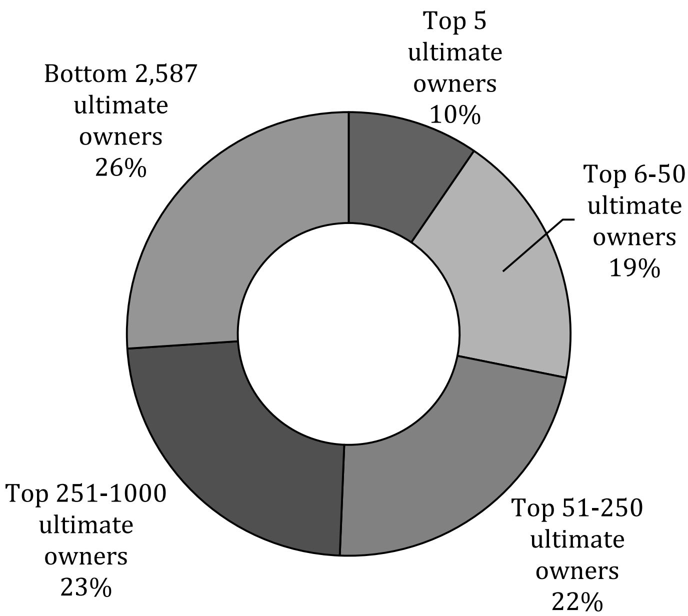
Table 3.1: Top ultimate owners of installations

Top ultimate owners	**Percentage total ultimate owners**	**Number installations**	**Percentage installations**
5	0.1%	1,045	10%
10	0.3%	1,572	14%
20	0.6%	2,149	20%
50	1%	3,081	28%
75	2%	3,596	33%
100	3%	4,013	37%
250	7%	5,539	51%
750	21%	7,570	69%
1,000	28%	8,088	74%
3,587	100%	10,938	100%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

EU ETS installations are, in turn, unevenly distributed between ultimate owners. A small proportion of entities ultimately own a relatively large proportion of installations, while most ultimate owners own very few. On one hand, 2,324 ultimate owners, representing 65% of the total, each own just one installation. On the other hand, three entities, the French Government, GDF Suez and E.ON, each ultimately own over 200 installations. Table 3.1 and Figure 3.1 represent this uneven distribution of installations by ranking ultimate owners in incremental groups according to how many installations they have controlling stakes in. The table and figure show that by splitting the ranked list of installations down the middle, 250 ultimate owners, representing 7 per cent of all ultimate owners, control half of all installations. The other half of installations are ultimately owned by 3,337 entities, representing 93 per cent of ultimate owners. The upper end of the ultimate ownership rankings is even more skewed. Just five ultimate owners, which account for 0.1 per cent of the total, control 10 per cent of installations, 20 ultimate owners (0.6%) control one-fifth of installations and 75 (2%) ultimately own one-third of installations. In sum, a relatively small proportion of ultimate owners control the installations at which carbon is appropriated within the EU ETS

Figure 3.1: Top ultimate owners of installations



Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Ultimate owners of EU ETS emissions

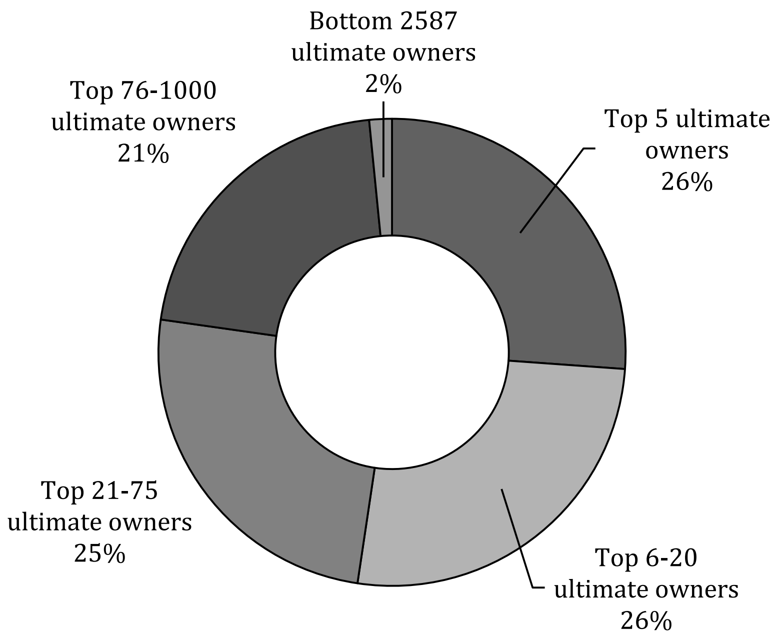
The extent of internal variegation among ultimate owners is even greater for control over emissions compared with installations. This suggests that the surplus maximising benefits of carbon-intensive production processes are being appropriated by a very small proportion of ultimate owners. Just five ultimate owners (0.1% of total) are responsible for over a quarter of emissions, 20 (0.6 %) are responsible for more than one-half of emissions and 75 (2%) are responsible for more than three-quarters of emissions. Conversely, 2,587 ultimate owners, representing 72 per cent of all ultimate owners, are responsible for just 2 per cent of 2005-12 verified emissions. Table 3.2 and Figure 3.2 again break down these results into various segments of ultimate owners, ranked in terms of total emissions, to illustrate the clustering of emissions among the top ultimate owners and comparatively low emissions from the vast number of ultimate owners.

Table 3.2: Top ultimate owners of 2005-12 emissions

Top ultimate owners	Percentage total ultimate owners	05-12 emissions (Mt CO_2-e)	Percentage emissions
5	0.1%	3,906	26%
10	0.3%	6,052	40%
20	0.6%	7,825	52%
50	1%	10,478	70%
75	2%	11,542	77%
100	3%	12,194	82%
200	6%	13,411	90%
500	14%	14,362	96%
1,000	28%	14,709	98%
3,587	100%	14,943	100%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Figure 3.2: Top ultimate owners of 2005-12 emissions



Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 3.3: Top 20 polluting ultimate owners

#	*Ultimate owner*	05-12 emissions (Mt CO_2-e)	Percentage 05-12 emissions	Sector (NACE Rev. 2)
1	*RWE AG*	1,053	7%	Production of electricity
2	*E.ON SE*	768	5%	Production of electricity
3	*Government of Sweden*	742	5%	Production of electricity
4	*Government of Poland*	674	5%	Production of electricity
5	*Enel SpA*	669	4%	Production of electricity
6	*Government of France*	527	4%	Production of electricity
7	*ArcelorMittal SA*	488	3%	Manufacture of basic iron and steel and of ferro-alloys
8	*GDF Suez*	442	3%	Production of electricity
9	*Government of Greece*	399	3%	Production of electricity
10	*Government of the Czech Republic*	290	2%	Electric power generation, transmission and distribution
11	*Iberdrola SA*	208	1%	Production of electricity
12	*Tauron Polska Energia SA*	189	1%	Production of electricity
13	*Eni SpA*	188	1%	Production of electricity
14	*Tata Steel Limited*	186	1%	Manufacture of basic iron and steel and of ferro-alloys
15	*KSBG GmbH & Co KG*	180	1%	Production of electricity
16	*Drax Group plc*	174	1%	Production of electricity
17	*SSE plc*	170	1%	Production of electricity
18	*Total SA*	168	1%	Manufacture of refined petroleum products
19	*EDP - Energias de Portugal SA*	157	1%	Production of electricity
20	*Riva Fire SpA*	152	1%	Manufacture of basic iron and steel and of ferro-alloys

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

The disproportionately high emissions from a small number of individual ultimate owners makes analysis of the appropriation of carbon by these particular entities both practically possible and necessary for understanding the distribution of emissions in the EU ETS. Table 3.3 provides a list of the corporations and governments that make up the top 20 polluters in order of the quantity of emissions historically attributable to the installations they currently own. Combined, these top 20 polluters were responsible for 52 per cent of 2005-12 emissions in the EU ETS. 16 out of the top 20 ultimate owners released their highest share of emissions from installations in the electricity sector, with the remainder in manufacturing: three in iron and steel production and one in petroleum refining (see Appendix for sector-matching method).

The appropriation of carbon by the largest polluters in the EU ETS is therefore dominated by the combustion of fossil fuels for electricity production. Iron and steel and oil refining involve the combustion of fossil fuels for energy too, but also appropriate carbon by using fossil fuels as a feedstock in production processes. Private German energy giant RWE tops the list by alone accounting for 7 per cent of 2005-12 emissions released in the EU ETS companies database, with E.ON the next biggest at 5 per cent of 2005-12 emissions . All account for at least one per cent of 2005-12 emissions.[3]

EU ETS emissions and installation size

The uneven distribution of emissions according to ultimate owner can be partly attributed to the same corporation or government owning a large number of individual installations. Indeed, the top 20 ultimate owners, which represent less than 1 per cent of ultimate owners, own 14 per cent of installations. It can also be attributed to ownership of individual installations that release a large amount of carbon emissions in their own right. For example, Drax Group, the 16th largest polluter in the EU ETS, which is alone responsible for 1 per cent of all emissions in the companies database, is the ultimate owner of a single power plant: the 4,000MW Drax coal-fired power station in

[3] Ultimate ownership of EU installations is constantly in motion. For example, following the completion of the matching exercise, the 21st and 34th largest polluting ultimate owners, cement producers LaFarge and Holcim, merged, while GDF Suez rebranded as ENGIE. The analysis in this thesis uses ownership information current at the *Orbis* export date of 16 July 2014, unless otherwise noted.

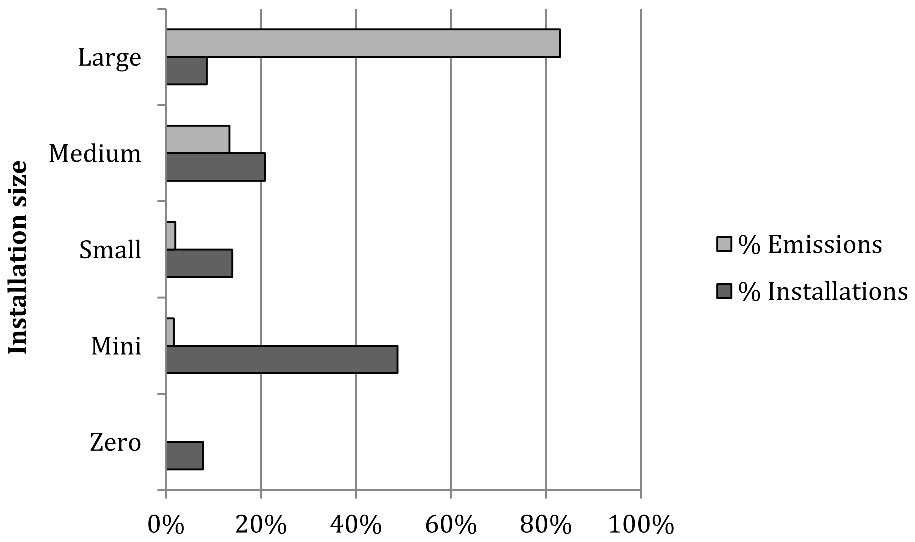
North Yorkshire, England (Drax Group, 2014). The distribution of emissions in the EU ETS between greater and lesser polluting installations can be mapped using the European Environment Agency's (2014b: 18) five installation sizes, based on the largest quantity of carbon dioxide-equivalent released in any one regulated year: zero (0Kt), mini (0-25Kt), small (25-50 Kt), medium (50-500Kt) and large (500+Kt).

Table 3.4: 2005-12 verified emissions by installation size

Size	**Installations**	**Percentage installations**	**05-12 Emissions (Mt CO_2-e)**	**Percentage emissions**
Zero	855	8%	0	0%
Mini	5,333	49%	247	2%
Small	1,530	14%	297	2%
Medium	2,281	21%	2,002	13%
Large	939	9%	12,397	83%
Total	10,938	100%	14,943	100%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Figure 3.3: 2005-12 emissions by installation size



Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Once again, the distribution of emissions is highly uneven between the large proportion of installations that release relatively low amounts of emissions and the small proportion of installations that release significant amounts of carbon pollution. The vast majority of installations – 7,718, representing 71 per cent of installations – are zero, mini or small in size. However, they are responsible for only 4 per cent of emissions. Conversely, 939 large installations, representing only 9 per cent of all installations, are responsible for the vast majority of carbon emissions at 83 per cent. Table 3.4 and Figure 3.3 compare the number of installations with their proportion of emissions for each installation size to illustrate the disparities between different installations according to scale of emissions they release. Overall, this shows that not only do a small proportion of owners control many of installations at which carbon is appropriated within the EU ETS; the appropriation of carbon is heavily centred on a relatively small proportion of those facilities.

The zero-mini-small-medium-large breakdown of installation size conceals the high proportion of emissions that result from a smaller number of very large installations within the large category. Some installations are responsible for many times the 500kt of CO_2-e per year that is emitted by the smallest installations within the large category. For example, the largest installation, the state-owned 5,400MW brown-coal fired Bełchatów Power Station in Łódź Province, Poland, has released up to 35,000Kt of CO_2-e per year (PGE Group, 2015b).

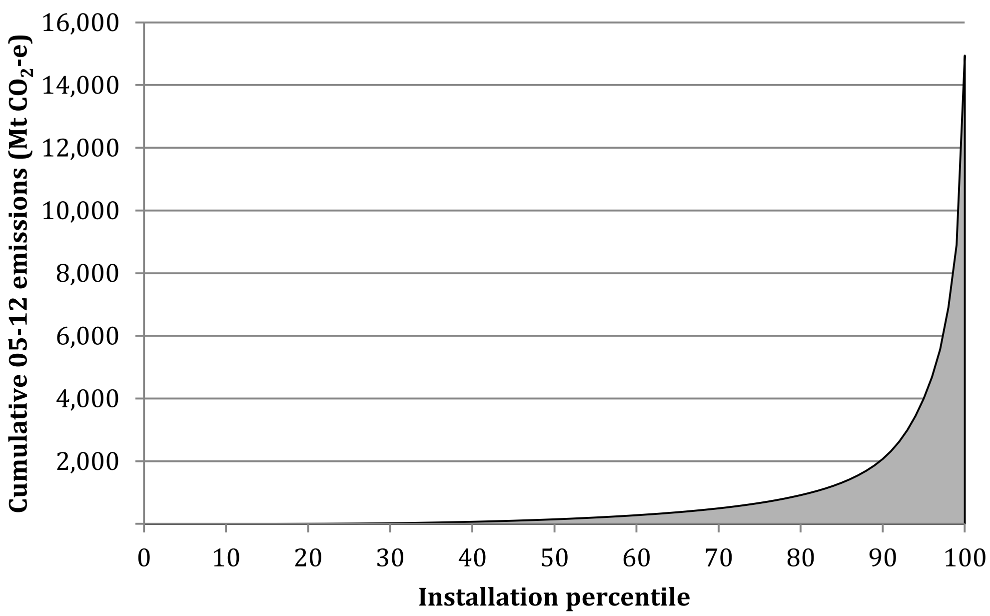
Table 3.5 breaks down the European Environment Agency's large category into five smaller categories. 70 per cent of large installations release up to 2,000Kt CO_2-e per year and 90 per cent release up to 5,000Kt CO_2-e per year. There are 83 installations, though, which emit more than 5,000Kt CO_2-e per year, ten times greater than the smallest installations within the large category. They account for less than 1 per cent of total installations but are responsible for more than one-third of total emissions in the EU ETS companies database. 67 (80%) are in the electricity sector, 14 (17%) manufacture steel and two (2%) are involved in refining oil. Figure 3.4 graphically represents the skewed distribution of emissions between installations according to the cumulative emissions of all installations in the companies database ranked in order of their size. The shape of the curve, which slowly increases for the majority of installations and rapidly increases in the highest percentiles, is due to the presence of very large polluting installations in the top 1 per cent of installation sizes.

Table 3.5: 2005-12 emissions by large installations

Size (max Kt CO_2-e pa)	Installations	Percentage total installations	05-12 emissions (Mt CO_2-e)	Percentage emissions
Large (500-2,000)	659	6%	3,688	25%
X-Large (2,000-5,000)	197	2%	3,466	23%
2X-Large (5,000-10,000)	58	0.5%	2,565	17%
3X-Large (10,000-20,000)	19	0.2%	1,524	10%
4X-Large (20,000+)	6	0.1%	1,154	8%
Total	939	9%	12,397	83%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n). Note: pa = per annum.

Figure 3.4: Cumulative emissions by installation size percentile



Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

EU ETS emissions and states

In addition to ownership of large-scale polluting installations, the uneven distribution of emissions among a small number of ultimate owners is characterised by a notable presence of states in the largest polluters. Five out of the top ten highest emitting ultimate owners are nation states (in order, the governments of: Sweden, Poland, France, Greece, and the Czech Republic). One other state-owned entity – Kommunale

Beteiligungsgesellschaft (KSBG), a consortium made up of municipal governments in the Rhine-Ruhr region of Germany – is in the top 20 polluters.

The companies database allows the full extent of state ownership across the EU ETS to be accounted for by aggregating emissions according to the ultimate owner 'type' assigned in *Orbis.* At a 50.01 per cent ownership path, over one-quarter of EU ETS emissions are directly controlled by states at the national, regional or local level. Most of this (17% of EU ETS emissions) comes from the particularly large state-owned companies in the top 20 polluting ultimate owners. By this measure, states are the second most significant ultimate owning organisation type behind conventional, publicly listed, industrial companies, which control 65 per cent of emissions. The only other notable ultimate owner type, individuals and families in privately owned business, controls 4 per cent of emissions.

Table 3.6: 2005-12 emissions by ultimate owner type

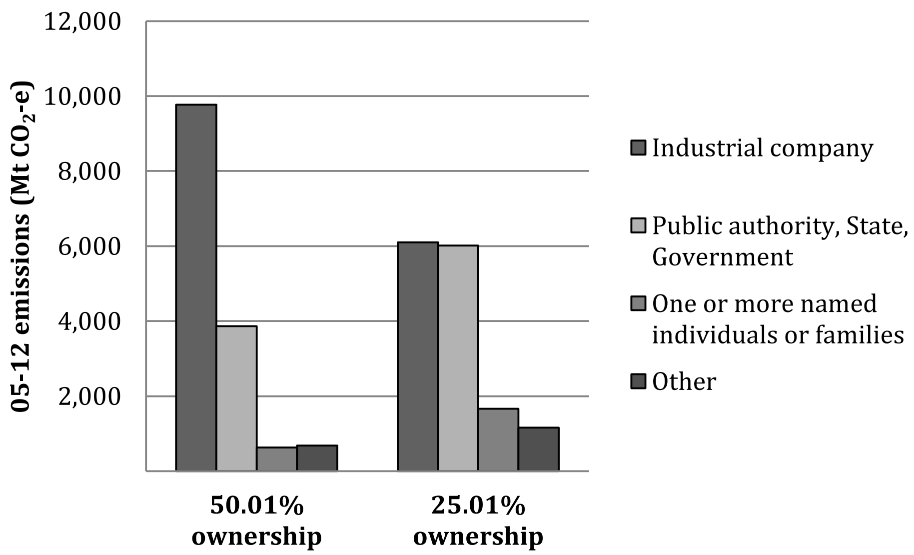
Type of company	**05-12 emissions (Mt CO_2-e, 50.01% ownership)**	**Percentage emissions**	**05-12 emissions (Mt CO_2-e, 25.01% ownership)**	**Percentage emissions**
Industrial company	9,768	65%	6,102	41%
Public authority	3,862	26%	6,019	40%
Individual or family	631	4%	1,665	11%
Other	682	5%	1,156	8%
Total	14,943	100%	14,943	100%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

However, the 50.01 per cent ultimate ownership path underestimates the extent of state control over emissions through direct ownership. While the measure is a necessarily conservative estimate of a controlling stake for the distribution of emissions between all ultimate owners in the EU ETS, states do not always operate like regular shareholders, particularly in formerly majority state-owned enterprises. Partial or even full privatisation often does not result in a relinquishing of government control due to special provisions for states to leverage minority stakes, such as special voting rights (Bortolotti and Faccio, 2009). Special voting rights for governments are commonly part of the terms of privatisation. Such rights may require government authorisation of, or limits to, private shareholders as well as the potential to shape or block management decisions through veto power or permanent representation on boards (European Commission, 2005: 5–6).

Using a 25.01 per cent largest ultimate owner rule therefore better captures the extent of government control over emissions for some companies. It still misses other ways in which governments leverage minority ownership levels below 25.01 per cent, such as through single 'golden shares'. Conversely, even if a greater than 25.01 and less than 50.01 per cent state ownership level does not come with any special provisions, it nonetheless constitutes a significant and potentially controlling stake depending on the relative equity of other shareholders. At this lower path, 40 per cent of emissions are from installations that are ultimately owned by states, fractionally less than emissions from industrial companies, which control 41 per cent of emissions. This includes emissions from four other top 20 ultimate owners – GDF Suez (France), Tauron (Poland), Enel and Eni (both Italy) – that have minority state ownership at levels above 25.01 per cent. Large-scale polluting installations are a significant contributing factor to the high level of state control over emissions. Out of the 83 largest installations, 26 are majority-owned by states, which increases to 47 at the lower ownership threshold.

Figure 3.5: 2005-12 emissions by ultimate owner type



Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 3.6 and Figure 3.5 break down emissions according to the three main and other company types at both 50.01 and 25.01 per cent ownership paths. 'Other' includes insurance companies, financial companies, banks, foundations, mutual and pension funds, trusts, private equity firms, and employee-owned companies, which each individually control an insignificant level of emissions. The table and figure show that between 26 and 40 per cent of emissions resulting from the appropriation of carbon in the EU ETS are controlled by public authorities through majority or minority state-owned companies.

The concentration and centralisation of emissions

Applying the lens of the theoretical framework developed in Chapter Two to understand the production of climate change, the uneven appropriation of carbon in the EU ETS, reflected in the uneven distribution of emissions between owners and installations, is a product of the uneven organisation of capital. If, as has been argued, nature is produced by capital "in its own image" then the image of capital that "instantiates" and "embodies" the organisation of emissions in the EU ETS is Marx's notion of the concentration and centralisation of capital (Harvey, 1996: 185; Smith, 2008: 83; Swyngedouw, 1999: 447). This section explores the relationship between Marx's notion and the uneven appropriation of carbon by drawing out the social and spatial dimensions of, and state-mediated conditions for, the concentration and centralisation of capital. Analysing the empirical findings in terms of the dynamics shaping the organisation and reorganisation of capital takes note of Swyngedouw's (1999: 447) argument that "following the maze of socionature's networks…is not good enough if stripped from the *process* of their historical-geographical production" (emphasis in original). The emphasis on process is particularly important because the companies database is an otherwise static presentation of historical responsibility for the appropriation of carbon at a particular point in time. Technological dependence on fossil fuels and the institutionalisation of the corporation are discussed with increasing levels of historical-geographical specificity, which continues in the next section's analysis of the reorganisation of largest polluters in the European electricity industry in the energy liberalisation period.

The concentration and centralisation of capital

In Volume I of *Capital*, Marx outlines how processes of concentration and centralisation develop under the capitalism. The concentration of capital is nothing more than the accumulation process itself, whereby capital compounds in the hands of those that control the means of production. It is "identical" to self-expansion of individual capitals, where "every accumulation becomes a new means of accumulation" (Marx, 1976: 776–7). By definition, capitalist production depends on some degree of concentration of the means of production and labour power under capitalist control. Within the totality of the social capital "every individual capital is a larger or smaller concentration of means of production, with a corresponding command over a larger or smaller army of workers" (Marx, 1976: 776). The greater the concentration of capital, the greater the foundation for expanded capital accumulation with every successful "re-conversion of surplus-value into capital" (Marx, 1976: 775).

The centralisation of capital is a different but related process to concentration. It also results in the formation of larger capitals, but via a different route. Instead of self-expanding through the accumulation process itself, larger capitals are formed by combining smaller ones. Centralisation therefore refers to changes in the distribution of individual "capitals already formed" via the "expropriation of capitalist by capitalist" (Marx, 1976: 777). Centralisation is in part a response by capitalists to the countervailing tendencies to the concentration of capital. Competition interrupts the concentration of capital by encouraging its de-centralisation through the establishment of new capitals. Marx (1976: 776–7) argues that "accumulation, therefore, presents itself on the one hand as increasing concentration of the means of production, and of the command over labour; and on the other hand as repulsion of many individual capitals from one another." Competition, however, also creates pressures for individually fragmented capitals to come together. Marx (1976: 779) describes competition and the credit system, which polices profitability and finances expansion, as the "most powerful levers of centralisation" because they drive capitals to combine through mergers and takeovers, in the hope of gaining some control over the anarchy of the market and advantage over their competitors.

Like the concentration of capital, centralisation becomes the basis for expanded accumulation, at least in the short-term. For example, new larger capitals can outcompete old smaller capitals by coordinating production on a larger scale. However, the "advance of centralisation does not depend in any way on a positive growth in the magnitude of social capital" and can in fact "supplement the work of capital accumulation" (Marx, 1976: 779). Herein lies the main advantage of centralisation vis-à-vis concentration for individual capitalists: it achieves the same outcome as the "gradual" process of concentration "overnight" (Marx, 1976: 780).

How then do patterns of concentration and centralisation of ownership of capital relate to the uneven distribution of carbon emissions in the EU ETS? Harvey (2006: 140) argues that "Marx is not explicit as to the kind of centralisation he is talking about (financial, productive etc.)." EU ETS emissions are unevenly organised both financially (ultimate ownership) and productively (installation size). Smith (2008: 160) distinguishes between these as the social and spatial dimensions of capital's concentration and centralisation. On one side of the coin, the social dimension refers to an increase in the financial quantity of capital controlled by individual capitals. On the other side of the coin, the spatial dimension refers to an increase in the physical scale of capital in particular places.

When this distinction is compared with the EU ETS emissions data, the uneven distribution of emissions between owners mirrors the social centralisation of capital and the uneven distribution of emissions between installations mirrors the spatial concentration of capital. The following two subsections discuss the relationship between the concentration and centralisation of capital and the concentration and centralisation of emissions by examining the historical contribution of technological dependence on fossil fuels and the institutionalisation of the corporation to the socio-spatial organisation of capitalist production. By linking the social organisation of capital with the material organisation of carbon-intensive production processes, it is argued that the uneven development of capital is internally related to the uneven appropriation of carbon.

Fossil fuels

Chapter Two drew on Benton (1989), as well as Burkett (1999) and Moore (2014c), to conceptualise the appropriation of carbon in terms of the congruence between the material properties of fossil fuels and capitalist social relations, which produces both surplus value and climate change. Histories of the introduction of the steam engine into manufacturing, and the subsequent development of thermal electricity generation, show that a key component of this congruence is the place of fossil fuels as a condition for the spatial concentration of capital.

From the late eighteenth and early nineteenth centuries, the coal-fired steam engine became the dominant source of energy for mechanical motion in British industry. This transition was not due to absolute shortages, or higher relative prices, of water power, coal's main contender (Malm, 2013: 47). Rather, it was due to coal's spatial and temporal advantages over water-based sources of energy within the logic and process of capital accumulation. Coal could be more easily transported from its source of extraction to place of use than water, which gave capital greater flexibility in determining the location of production because it did not require local sources of energy (Altvater, 2006: 41; Huber, 2009: 111). In temporal terms, coal provided a source of energy that was independent of water cycles. This meant energy could be more reliably deployed when required by capital, providing greater scope for coordinating production processes by combining labour power and the means of production when it was most profitable (Altvater, 2006: 51; Malm, 2013: 55).

Coal's spatial and temporal advantages over other energy sources were related to its support for large-scale industry. Whereas water power encouraged spatial decentralisation because expanded accumulation required absolute geographical expansion to find new sources of energy, coal was conducive to the spatial concentration of capital in larger factories and cities (Huber, 2009: 111; Malm, 2013: 54; Marx, 1976: 499). By enabling the spatial concentration of production, fossil fuels encouraged labour productivity improvements through an enhanced division of labour because it was possible to power multiple labour-saving machines at once, including machines producing machines, thereby creating the conditions for what Marx (1976:

499) termed a “system of machinery.” The spatial concentration of capital, in turn, facilitated social concentration by speeding up the circuit of capital.

Realising the productive force of fossil fuels in this way created new barriers for capitalist production due to the physical size of steam engines at places of production needed to achieve economies of scale (Smil, 2010: 54–5). The development of steam turbine generators and Edison’s system of electricity transmission and distribution from the late nineteenth century was able to overcome the barriers presented by the steam engine. This saw fossil fuels (coal, then also gas and oil) increasingly diverted to the production of thermal electricity. The development of electricity is especially important for understanding the organisation of emissions in the EU ETS due to the dominance of the sector in the largest polluting ultimate owners and installations.

Electric energy enhanced the benefits of the steam engine for capital by bring greater control of delivery to scale, time and place through its “superior final conversion efficiencies, unmatched productivity, and unequalled flexibility” in many areas of production (Smil, 2010: 39). Together with the development of electric motors in industry, thermal electricity generation overcame the spatial constraints stemming from the need to produce energy at the factory level by shifting it to large-scale power stations that could reach wide geographical markets with high voltage transmission lines (Millward, 2008: 114). Over the course of the twentieth century, the capacity of the largest coal-fired thermal power stations in the US increased from 40MW in 1900 to 4,000MW in the late 1970s, showing the role of fossil fuels in supporting the search for relative surplus value through ongoing technological development. The development of gas turbines following World War II also permitted smaller, dispatchable units to further support this ‘centralised’ energy model (Smil, 2010: 44–59).

The centralised electricity model was also replicated across many parts of Europe (Millward, 2008). For example, the history of electrification in the UK involved a transition from many small generators servicing local areas or single factories in the late nineteenth and early twentieth centuries to the establishment of a national transmission network serviced by a few large generators in the inter-war period. To illustrate, in 1920, 475 small power stations were in operation across the UK. By 1935, 15 larger generators provided over 50 per cent of total supply, under the regulation of the national government's rationalisation policies (Hannah, 1979: 84, 126). Spatial concentration was orchestrated by the state in order to maintain competitiveness with Germany and the US, which had developed a large-scale electricity production model somewhat earlier (Foreman-Peck and Millward, 1994: 258–9). The model was consolidated further in the immediate post-war period following nationalisation, when many of the top polluting EU ETS installations, such as the Drax Power station highlighted above – commissioned by the national government in 1968 – were built (Drax Group, 2014). The model has been maintained following privatisation since the 1990s as regulators and networks blocked access to smaller, intermittent generators (Mitchell, 2010: 149).

Large-scale power generation isn't limited to fossil fuels; nuclear and hydroelectric power stations are other sources. Further, the model has been eroded in some places, such as in western Denmark, which changed from having one of the world's most centralised electricity generation industries to one of Europe's highest proportion of small-scale distributed energy sources from the 1970s (Lehtonen and Nye, 2009). However, the prevalence of power stations among the very large-scale polluting installations in the EU ETS demonstrates the legacy and ongoing position of centralised fossil fuel-based electricity generation.

The corporation

The prevailing energy system is dependent not only on the spatial concentration capital in large-scale installations but also the social centralisation of capital that organises it (Bridge et al., 2013: 337). The institutionalisation of the corporation has been the primary means of coordinating large-scale production processes and in this sense complements fossil fuels as a condition for the social centralisation of capital.

The corporation, in the form of the joint stock company, grew quickly as the dominant institution for the organisation of capital in Britain following the repeal of the Bubble Act in 1825, which had previously slowed corporate growth following earlier high-profile collapses (Bryan and Rafferty, 2006: 80–1). The corporation 'socialised' capital by introducing a degree of separation between the ownership of capital and the production process, which transformed the relationship between capitalists and fixed capital. Rather than capitalists directly owning and controlling the means of production, it was the company that owned the physical assets and managers that controlled day-to-day operations. Capitalists instead owned tradeable shares in the company, denoting a financial share in the company's profits and losses. As a result, the locus of competition shifted from between individual capitalists in markets for goods and services to competition over ownership of companies in the stock market (Bryan and Rafferty, 2006: 84).

Social centralisation of capital in the corporate form provided the means to overcome barriers to capitalist expansion posed by individual capitals. It enabled the pooling of financial resources from fragmented capitals in order to invest in large-scale industry, and the integration of multiple production processes within the boundaries of the same unit of capital. The invention of limited liability also supported large-scale investment by reducing investor risks to their share of the company (Bryan and Rafferty, 2006: 79). Influential studies of the development of the corporation in the US from the second half of the nineteenth onwards identified a number of advantages of internal corporate coordination, such as via vertical integration, over external market coordination, for increasing productivity (Chandler, 1977: 7–11; Galbraith, 1969: 37–41).

In general, Western Europe adopted this model of a centralised organisation with a diversified, divisional internal structure from the beginning of the twentieth century and particularly in the post-war period (Whittington and Mayer, 2002: 10–14). More specifically, in the European electricity industry, the development of large-scale thermal power stations was co-constituted by the social centralisation of capital in increasingly large private and state-owned corporations. The development of bigger organisations out of the local privately and municipally owned entities that originally established electricity networks was needed to realise productivity gains made possible by technological developments in the inter-war period. Constructing large-scale thermal plants, connected to high-voltage, long-distance transmission lines, demanded significant financial resources. Larger organisational structures also enabled integration of coal mining, electricity production and transmission and distribution networks over large geographical areas (Millward, 2008: Chapter 8).

Both private and state owners of electricity infrastructure sought to centralise their organisational structures. In countries such as France, Italy and Spain, which had a history of private ownership, individual companies merged or came to other agreements to create regional monopolies, with states facilitating connections between regional networks (Millward, 2008: 117). Similarly, in Germany, municipal, state and national-level governments joined private owners to form joint stock companies, a precursor to the structure of many of the top polluting ultimate owners in the EU ETS with significant majority or minority state ownership (Millward, 2008: 135). Municipal ownership initially blocked integration in the UK, but this only paved the way for more dramatic centralisation via the state in post-war nationalisations.

In sum, fossil fuels and the corporation combined historically as conditions for the spatial concentration and social centralisation of capital. This combination has contributed to the socio-spatial concentration and centralisation of emissions evident in the uneven distribution of emissions among installations and owners in the EU ETS. Both spatial concentration and social centralisation express, and intensify, capitalist social relations. Huber (2009: 109–10) argues that fossil fuels "hastened the generalisation and extension of the wage labour relationship on an expanded scale heretofore unseen" by rendering human labour increasingly dispensable and therefore subordinate. Kay (1995: 160–1) makes a parallel argument in relation to the joint stock company, on the basis that corporate capital more closely resembled capital's "pure" form of self-expanding value, because it made "the subject legally responsible for a joint-stock company…the company itself." But, consistent with O'Connor (1998), the history the infrastructural and ownership configurations of the electricity industry shows capitalist social relations with nature were also mediated by states. The next section demonstrates that states have maintained their central position in organising the appropriation of carbon in the recent energy liberalisation era.

Reorganising emissions in the European electricity industry

The recent history of the European electricity industry has been punctuated by European Commission's agenda of energy liberalisation, which has been progressively rolled out in a series of directives from the European Parliament and Council from 1996 (e.g. European Parliament and Council, 2009). The aim of the agenda has been the creation of an 'internal market' for electricity (and gas) in the EU by, among other things, unbundling high voltage transmission networks, low voltage distribution networks, electricity generators and retailers into separate entities and opening up these new separate markets to competition. Despite, and in some cases because of, inconsistent implementation of the EU's liberalisation directives by member states, the liberalisation agenda has created the "policy space" for the consolidation of energy companies at the European level (Clifton et al., 2010: 990; Kolk et al., 2014; Thomas, 2003).

The processes leading to this outcome are explored in this section by identifying public ownership, privatisation and competition policy as three different state-embedded vehicles for the concentration and centralisation of the European electricity industry. Liberalisation has gone hand-in-hand with privatisation in many parts of the world (Beder, 2003). In Europe, liberalisation directives have catalysed, but cannot enforce, privatisation because under the *Treaty on the Functioning of the European Union* the EU is neutral on questions of state ownership (Clifton et al., 2006: 751–2; European Union, 2012b: Article 345). As a result, energy liberalisation has opened up pathways for international expansion for both publicly owned and privatised companies. Competition policy encompasses a range of laws, regulations and institutions ostensibly designed to promote competition and free trade in markets and prevent anti-competitive behaviour or market structures (Christophers, 2015: 126). Yet, its application by EU authorities over the energy liberalisation period has largely facilitated the series of mergers between and takeovers of fossil fuel-intensive energy companies that resulted in the consolidation of the industry.

Figure 3.6: Consolidation of the European electricity industry

Ultimate owner	**Original merger between**	**Highlighted acquisitions**	**EU ETS countries**	**Very large installations (>5Mt CO_2-e pa)**	**Largest installation**
RWE AG		VEW (2000), Essent (2009), Innogy (2002)	Belgium, Czech Republic, UK, Hungary, Netherlands and Poland	9	2,800MW Niederaussem power plant (Germany)
E.ON SE	VEBA and VIAG (2000)	Powergen (2002), TXU (2002), Endesa assets (2008)	Belgium, Czech Republic, UK, Hungary, Netherlands, Poland, Denmark, Spain, Italy, France, Sweden and Slovakia	5	2,200 MW Scholven power plant (Germany)
Government of Sweden (Vattenfall)		HEW/BEWAG (1999), VEAG (2002)	Netherlands, Germany, Sweden and Denmark	5	3,000 MW Jänschwalde power plant (Germany)
Government of Poland (PGE, Enea, PGNiG and Energa)	Individual power plant companies (2004-07)		Poland	5	5,400 MW Bełchatów power plant (Poland)

Ultimate owner	**Original merger between**	**Highlighted acquisitions**	**EU ETS countries**	**Very large installations (>5Mt CO_2-e pa)**	**Largest installation**
Enel SpA		Endesa (2007), Slovenské Elektrárne (2006)	Italy, Spain, Slovakia, Belgium and Portugal	8	2,600MW Federico II power plant (Italy)
Government of France (EDF)		Edison (2005), London Electricity (1998)	France, Belgium, Spain, UK, Hungary, Italy and Poland	4	2,000 MW West Burton power plant (UK)
GDF Suez	GDF and Suez (2008)	Electrabel (2000), International Power (2010)	France, Belgium, Germany, Spain, UK, Hungary, Italy, Netherlands, Norway, Portugal, Poland and Luxembourg	3	1,600MW Połaniec power plant (Poland)

The three state vehicles of public ownership, privatisation and competition policy are not the only relevant forms of state action. For example, direct state provision of large-scale infrastructure such transmission networks is crucial for inter-country electricity trading, which is envisaged as central to the expansion of liberalised energy markets but also supports the centralised energy model (Gerebizza and Tricarico, 2013). A detailed analysis of the different national specificities, such as political debates over energy security and affordability that have shaped the reorganisation of the electricity sector, is beyond the scope of the section. Its primary purpose is to demonstrate the close relationship between the concentration and centralisation of capital and the uneven appropriation of carbon, and the significant role of states within this. Figure 3.6 summarises the mergers and acquisitions highlighted in this section that led to the consolidation of the EU electricity industry and its consequences in terms of control over large polluting installations across multiple countries.

Public ownership: Vattenfall, EDF and PGE

The Swedish, French and Polish states' emissions are primarily due to their respective national electricity companies: Vattenfall, Électricité de France (EDF) and Polska Grupa Energetyczna (PGE). EDF is the product of the nationalisation of the French electricity industry in 1946. The French government, along with the governments of the UK, Italy, Ireland, Greece and Portugal, all pursued the nationalisation of electricity assets as part of a broader suite of "national-developmentalist practices" to drive post-war economic growth by securing reliable and low cost supply for industry and households (Beder, 2003: 189–9; Brenner, 1998: 475). Many of PGE's assets were also commissioned during the same period, when Soviet-aligned countries including Poland also developed national-scale electricity networks (Beder, 2003: 189–90). The organisational origin of PGE lies, however, in the post-1990 restructuring of the industry (Kamiński, 2012). Vattenfall was established much earlier, in 1909. The Swedish electricity sector wasn't fully nationalised, which meant Vattenfall had private competitors, but the development of the state-owned entity as the dominant generator was nonetheless fostered by the Swedish government following the nationalisation of the transmission network in 1949 (Högselius, 2009: 259).

All three major state-owned polluters have assumed corporate institutional forms. In 2005, EDF became a publicly-traded, majority state-owned, corporation, when 15 per cent of the French government's shares were sold and the company listed on Euronext Paris (EDF Group, 2014b). Similarly, in 2009 PGE was listed on the Warsaw Stock Exchange and since then 40 per cent of government shares have been progressively sold to private shareholders (PGE Group, 2015a). Vattenfall remains unlisted and in 100 per cent state ownership, but changed from a government agency to a fully corporatised entity in 1992 (Högselius and Kaijser, 2010: 2248; Vattenfall, 2013).

In the context of energy liberalisation in other parts of Europe, ongoing ownership by the French and Swedish governments has been a vehicle for the concentration and centralisation of emissions across Europe due to the opportunities liberalisation affords for geographical expansion. In France, some limited transcription of EU liberalisation policies has partly reduced EDF's share of the domestic market, but more extensive liberalisation in other countries has supported its expansion to other European markets, such as the acquisition of Edison in Italy from 2005 and London Electricity in the UK in 1998 (Bauby and Varone, 2007: 1050–5; Thatcher, 2007; van den Hoven and Froschauer, 2004). The latter acquisition was paved by the precursor to EU-level liberalisation, the privatisation of the UK's electricity industry in 1990, which also opened up the UK market for privately-owned companies including the top two polluters, RWE and E.ON. Vattenfall has engaged in a similarly aggressive internationalisation strategy. For example, it acquired Hamburgische Electricitäts-Werke (HEW) (and through it, Berlin's BEWAG) and Vereinigte Energiewerke (VEAG), both based in Germany, in 1999 and 2002, respectively. Again, HEW was acquired following privatisation, this time from the government of Hamburg. Vattenfall purchased a minority stake directly from the government before achieving a majority stake by purchasing shares from other original beneficiaries of privatisation, including E.ON (Högselius, 2009: 260–265).

The social centralisation of capital in the hands of EDF and Vattenfall has necessarily constituted a social centralisation of emissions due to the fossil fuel dependence of the acquired companies. In 2013, EDF's fuel mix was 4 per cent fossil fuels inside France, due to a high proportion of nuclear, compared with 75 per cent in Italy and 30 per cent in the UK (EDF Group, 2014a: 13–17). As a result of these and other geographical expansions, 67 per cent of the French government's emissions in the EU ETS companies database come from outside of France (in Belgium, Spain, the UK, Hungary, Italy and Poland). EDF owns four of the 83 very large (over 5Mt CO_2-e per year) emitting power stations highlighted above, three of which – two in the UK, one in Poland – are also outside of France. The largest two polluting installations owned by EDF are twin 2,000MW coal-fired power stations, West Burton and Cottam, in Nottinghamshire, the UK, which were commissioned in 1961 and 1966, respectively (EDF Energy, 2015). Similarly, 93 per cent of the Swedish government's EU ETS emissions in the companies database come from Germany and the Netherlands, due to the high proportion of fossil fuels in Vattenfall's non-Nordic operations, compared with its Nordic electricity fuel mix, which is all nuclear, hydro and renewable (Vattenfall, 2014). All five of Vattenfall's very large power stations are in Germany. This includes the fourth largest polluter in the EU ETS, and largest brown coal-fired power station in Germany, the 3,000MW Kraftwerk Jänschwalde in Peitz, Brandenburg, near the German-Polish border. It was first commissioned in 1976 and came under Vattenfall's control following the takeover of VEAG (Vattenfall, 2015).

State ownership has played a different role in encouraging the concentration and centralisation of emissions in Poland. The Polish government implemented a policy of centralising the state-owned energy sector in the mid-2000s by consolidating the state-owned companies originally established in the early 1990s to operate individual power plants, in order to improve financing prospects for investment requirements (Kamiński, 2012: 138). PGE was formed through a process of consolidations between 2004 and 2007, which combined the companies operating the largest polluting installation in the EU ETS, the Bełchatów power station discussed above, and those operating three other power stations that have released over 5Mt CO_2-e per year: the Turów, Opole and Dolna Odra coal-fired plants. This process centralised the Polish state's control over emissions into four main companies: PGE, which makes up 70% of its EU ETS emissions, as well as Enea (which also owns one very large polluting installation), PGNiG and Energa.

However, state ownership in Poland has not facilitated the international centralisation of emissions, as with the Swedish and French governments, through outward expansion. In fact, all of the Polish Government's EU ETS emissions occur within domestic borders. Rather, the domestic centralisation of emissions, with 94 per cent of generating capacity being controlled into eight companies by 2008, paved the way for the international centralisation of emissions because other international companies could buy large chunks of the Polish energy market when four of the companies were privatised (Kamiński, 2012: 139). Hence, national decentralisation of ownership away from the Polish state through the privatisation was countered by the international centralisation of ownership at the European level, when other top eight ultimate owning polluters EDF, Vattenfall and GDF Suez acquired stakes in formally state-owned Polish energy companies (Kamiński, 2012: 139).

Privatisation: Enel and GDF Suez

Privatisation has also been a vehicle for the concentration and centralisation of emissions for Enel and GDF Suez, the EU ETS's fifth and eighth biggest polluting companies. As flagged above, Enel is a product of the nationalisation of the Italian electricity industry in the early 1960s, which was privatised from 1999 in conjunction with Italy's transposition of the EU's energy liberalisation directives (Ferrari and Giulietti, 2005). GDF Suez came about through the simultaneous 2008 privatisation of Gaz de France (GDF), the gas-based equivalent company of EDF, created as part of the same nationalisation policy, and merger with Suez, a private French corporation with a history dating to the nineteenth century (ENGIE, 2015). Both the Italian and French governments have maintained substantial stakes of over 30 per cent in Enel and GDF Suez, respectively.

As part of its implementation of energy liberalisation, a condition of Enel's privatisation was that its Italian market share was restricted to 50 per cent of national capacity, which required divestment from 15,000MW of installed generating capacity before 2003 (Ferrari and Giulietti, 2005: 252; Goldstein, 2006). The actual experience of this restriction illustrates how liberalisation facilitates the concentration and centralisation of emissions. First, it opened up Enel's assets for other international companies. Indeed, one of the three Enel subsidiaries that was sold off to meet this competitive requirement, Interpower, was purchased by a consortium including Electrabel, then owned by Suez (Enel, 2002). GDF Suez continues to ultimately own Suez's part of the assets through Tirreno Power. Secondly, the decentralisation from Enel as a result of the divestment was more than compensated by Enel's acquisition of Spanish utility Endesa in 2007, which by 2013 had 40,000MW of installed capacity (Kolk et al., 2014: S87).

Enel's international expansion involved a centralisation of emissions because 58 per cent of Endesa's generation is from fossil fuels, compared with 53 per cent for Enel's operations within Italy (Endesa, 2014: 13; Enel, 2014a: 22). Enel's emissions are as a result fairly evenly split between Italy (52%) and Spain (44%). The other emissions are primarily from Slovakia (4%), due to the takeover of former state-owned Slovenské Elektrárne, with smaller emissions also from Belgium and Portugal. Of Enel's eight very large power stations, Italy and Spain host four each. The largest is the 2,600MW Federico II station in Brindisi, southern Italy, which is the eighth biggest polluting installation in the EU ETS, commissioned in 1991 (Enel, 2015).

The GDF Suez privatisation and merger was executed by the French government in response to an attempted takeover of Suez by Enel, in order to keep Suez in French ownership and increase the competitiveness of GDF in the European market (Bauby and Varone, 2007: 1054; Kolk et al., 2014: S85). The state-driven centralisation of capital built on the previous expansion of each company into Belgium and the Netherlands, the most significant being Suez's acquisition of Belgium-based company Electrabel in 2000. This has continued with GDF Suez's acquisition of the UK's International Power in 2010 (Kolk et al., 2014: S88). The social centralisation of emissions that accompanied the creation and expansion of GDF Suez is evident in the wide geographical distribution of its emissions between France, Belgium, Germany, Spain, the UK, Hungary, Italy, the Netherlands, Norway, Portugal, Poland and Luxembourg. Only 11 per cent of these emissions come from inside France, with Belgium (21%) and the UK (20%) making up the largest shares. GDF Suez owns three of the very large EU ETS installations, situated in Poland, the Netherlands and the UK, the largest being the 1,600MW Połaniec power station in Świętokrzyskie, south-east Poland (GDF Suez Energia Polska, 2015)

The cases of Enel and GDF Suez illustrate the importance of treating minority state ownership as a special case because the terms of both privatisations preserved a level of control for states that would not be afforded to private shareholders with the same level of equity. A condition of Enel's privatisation was that non-state shareholders could not control more than 3 per cent of shares and associated voting rights, which provides significant leverage to the Italian government's 25.5 per cent stake (Enel, 2014b: 4). Similarly, French law preserves at least a one-third state ownership stake in GDF Suez, and affords the government additional powers to preserve "the essential interests of France in the energy sector, as regards the continuity and security of energy supply" (GDF Suez, 2014: 3).

Competition policy: RWE and E.ON

Lastly, the concentration and centralisation of capital and emissions in the top two polluting ultimate owners in the EU ETS, German energy corporations RWE and E.ON, has occurred under long-term private ownership. Although the histories of both were shaped by state ownership and privatisation, regulation through competition policy has been a greater state influence over their reorganisation in the energy liberalisation period.

Competition law was first introduced in the United States with the Sherman Act of 1890, followed by the Clayton Act of 1914, and was included as part of the establishment of the European Economic Community in 1957, in response to concerns about the formation of monopolies and cartels (Gerber, 2001: 8; Papadopoulos, 2010: 11). Since the mid-1970s, competition policy has increasingly become preoccupied with questions of price efficiency (Davies, 2010). The effect of this move has been that rather than acting as a barrier to the concentration and centralisation of capital, monopoly structures are justified if they allow efficient behaviour, which is commonly assumed to be the case by the neoclassical theory informing the assessment (Christophers, 2012: 566). This has been the lens that has guided EU competition policy in the implementation of energy liberalisation.

Between 1997 and 2004, the nine largest electricity companies in Germany merged to become four, with E.ON and RWE as the two largest (Thomas, 2003: 395–6). RWE was established in 1898 in private ownership, but adopted public-private ownership structures at different points throughout the twentieth century. This included periods of majority municipal ownership from 1920, although notable government stakes are currently limited to a 15 per cent shareholding by city governments in the state of North Rhine-Westphalia (Millward, 2008: 135; RWE, 2015). RWE began as the largest of the nine and further centralised within the German market through its takeover of VEW, based in the same region, in 2000. E.ON was also established in 2000 through the merger of the second and third biggest companies, VEBA and VIAG. The two companies were first established in 1929 and 1923, respectively, as state-owned enterprises and were gradually privatised between the 1960s and 1980s by the West German government (E.ON, 2015b; Millward, 2008: 184).

EU and national authorities judge the competition implications of such mergers with reference to the geographical scope of market boundaries, which in the energy sector is generally defined according to the reach of transmission networks. This has resulted in the EU competition authorities imposing some national restrictions due to the existence of better national network connections, while largely facilitating international expansion, due to more limited connections (Verde, 2008: 1131). Within the German market, the takeover of VEW by RWE and the VEBA/VIAG merger to form E.ON were approved by the European Commission and Germany's Federal Cartel Office on the condition that they divest shares in VEAG (which as explained above simply opened up the market for Vattenfall) (European Commission, 2000a). Domestic restrictions were also imposed by the European Commission as part of its approval of RWE's takeover of Dutch company Essent in 2009, with RWE being forced to sell some of Essent's German assets in the process (European Commission, 2009b). Conversely, RWE's acquisition of Innogy (now nPower) and E.ON's acquisition of Powergen were both approved because the UK and German energy markets were assessed as being separate markets (European Commission, 2001b, 2002b). Indeed, liberalisation in the UK was used to facilitate, not restrict, further domestic centralisation by E.ON, which was allowed to acquire further UK assets from TXU Europe on the basis that market pressures from EDF, RWE and others would prevent an anti-competitive outcome (European Commission, 2002a). Lastly, the European Commission has also overruled national competition authorities when they have attempted to stop mergers. E.ON's acquisition of some of Endesa's assets (with most going to Enel, as explained above) followed a ruling by the European Commission that the Spanish government's attempts to impose restrictions on Enel's and E.ON's bids for Endesa were illegal because they breached EU law on the free movement of capital and goods (Domanico, 2007: 5068; European Commission, 2006b, 2007).

The domestic conditions imposed on RWE and E.ON have failed to substantially restrict the market share of either company in Germany, which each producing about one-quarter of German electricity in 2013 (Appunn and Russell, 2015). Thus, despite international expansion, and the substantial internationalisation of emissions that this entailed, 71 per cent of RWE's EU ETS emissions, and 39 per cent of E.ON's, come from installations within Germany. The extent to which competition authorities have facilitated international expansion is nonetheless shown by the long list of countries RWE, and particularly E.ON, record EU ETS emissions within. Both companies own installations that pollute in Belgium, the Czech Republic, the UK, Hungary, the Netherlands and Poland, with E.ON also polluting in Denmark, Spain, Italy, France, Sweden and Slovakia. E.ON owns five very large installations, in Germany, the UK and the Netherlands, the largest of which is the 2,200MW black coal-fired Scholven power plant, in Gelsenkirchen, North Rhine-Westphalia, Germany, first commissioned in 1968 and the thirteenth largest installation in the EU ETS (E.ON, 2015f). RWE owns nine of the largest installations in the EU ETS, in Germany, the UK, Hungary and the Netherlands. This includes four of the ten most polluting installations, all of which are in Germany, including the 2,800MW Niederaussem power plant, Bergheim, North Rhine-Westphalia, first commissioned in 1963, and second largest polluting installation in the EU ETS (RWE, 2014b).

Conclusion

The consolidation of the European electricity sector demonstrates in a concrete way how capitalist social relations, actors and institutions have produced climate change within the boundaries of the EU ETS. An equivalent analysis could be conducted, with somewhat similar results, in sectors such as the EU steel industry, which shifted from a largely nationally-bounded industry, with majority public ownership, to an international, privatised industry, where 60 per cent of EU production is controlled by five companies (Ecorys, 2008: 21–2). In both sectors, the concentration and centralisation of capital involved the concentration and centralisation of emissions, as fewer and fewer ultimate owners have taken control of more and more fossil fuel-intensive companies and their large-scale polluting assets. In accordance with the production of nature framework developed from Smith, Harvey and Swyngedouw in Chapter Two, this shows that the uneven development of capital occurred through the uneven appropriation of carbon. The externalisation and universalisation of the causes of climate change by orthodox economics combine to conceal this social unevenness underlying the production of climate change.

Technological dependence on fossil fuels and the institutionalisation of the corporation have been key conditions of this process, which finds its underlying logic in capitalist social relations. That the relationship between fossil fuels and the corporation and the systemic socio-spatial concentration and centralisation of capital was not automatic is evident in the prior use and existence of each condition. Coal was a significant source of energy and heat in British industry by the second half of the seventeenth century, prior to the spatial concentration that occurred with the steam engine, and the joint stock company had its origins in the mercantilist period, before the social centralisation that occurred with the rise of the modern corporation (Ekelund and Tollison, 1980; Smil, 2010: 29). However, when large-scale industry became necessary to reduce socially necessary labour time in the history of capitalist development, the corporation and fossil fuels were conditions for its realisation.

Both conditions have been actively guided by states throughout, most recently through direct public ownership, privatisation programs and competition policy. A comparison of the significant consolidations that have occurred in the energy liberalisation period, and the pre-energy liberalisation period original commissioning dates of the largest emitting power stations, suggests that social centralisation has been more significant than spatial concentration in the organisation of capital and emissions in recent times, although the former supports the maintenance of the latter. The multiple ways in which states have shaped the production of climate change underscores the need of an approach to the relationships between states and carbon markets that appreciates the broader structural position of capitalist states in regulating the conditions of production.

The concentration of the EU ETS market has also been considered by orthodox economists. Convery and Redmond (2007: 101–2) apply the standard Herfindahl-Hirschman Index (HHI) of market share to allowances, which have largely followed emissions due to free allocation practices, and conclude that there is a low level of concentration in the EU ETS allowance market as a whole and in the electricity sector. The key concern here is the ability to manipulate carbon prices away from marginal abatement costs generating inefficient outcomes. Whether HHI accurately captures this has been challenged by other economists (Hintermann, 2010, 2014). However, an approach to market power that focuses on price manipulation misses the broader significance of the uneven distribution of emissions (and allowances) for assessing the efficacy of carbon markets as climate policy.

The EU ETS is constituted by many actors that have made a very marginal contribution to climate change, and a few actors that have made, and continue to make, a significant contribution to the problem. The implications of understanding climate change in terms of the uneven appropriation of carbon for the central research question of this thesis is that the efficacy of the EU ETS depends on the impact of the instrument on the large-scale polluting installations and major polluting corporations that disproportionally transform the climate. The companies database developed at the beginning of this chapter provides the empirical basis for identifying these actors as a focus of the analysis of the commodification of carbon in the EU ETS and CDM/JI in Part Two of the thesis.

Part II: Commodifying carbon

4 – Exploiting internal differentiation

Introduction

This part of the thesis moves towards a critical appraisal of the socio-ecological efficacy of the EU ETS – including its links with the Kyoto mechanisms, the focus of the next chapter – by considering how the formal equality of the carbon market relates to the substantive inequality between the actors its regulates. Its purpose is to evaluate the extent to which the EU ETS addresses the factors underpinning the production of climate change that were highlighted in the previous part of the thesis. Given the highly uneven patterns of carbon appropriation that were uncovered, the research question that follows is: how has the EU ETS and its associated offsetting schemes affected the organisation of emissions between polluting owners and installations? The question is necessary because, contrary to orthodox economic logic, the actions of particular actors matter for the efficacy of climate policy because some owners and installations make greater contributions to the climate problem than others.

The current chapter and the next are structured according to the development, design and operation of the EU ETS and the CDM/JI, respectively. The conceptual focus shifts to the commodification of carbon as the main organising logic and mechanism of market-based climate policy. Commodification represents familiar terrain for critical analyses of carbon markets (Bumpus, 2011; Descheneau, 2012; Knox-Hayes, 2013; Lohmann, 2005, 2011b; Lövbrand and Stripple, 2012; MacKenzie, 2009; Paterson and Stripple, 2012; Stephan, 2012). This chapter draws on much of this work while aiming to address a number of gaps, including the insufficiently relational conception of the carbon commodity in the EU ETS and the under-theorisation of configurations of space and time in the Kyoto mechanisms. It develops a distinctive understanding of the commodification of carbon, building on Part One of the thesis, by conceptualising carbon allowances and carbon offsets as particular representations of the capitalist appropriation of carbon. What relations are captured within these commodified representations, and how they are initially distributed and then traded, forms the basis of the evaluation of the socio-ecological outcomes of the policies.

The first section of this chapter follows the development of the EU ETS from its proposal by the European Commission's (the Commission) Directorate-General for the Environment in 1999, the subsequent Green Paper on the subject in 2000, its drafting as a proposed Directive in 2001 and final agreement by the European Parliament (the Parliament) and Council of the European Union (the Council) in 2003 (Wettestad, 2005: 4–8). Drawing on the extensive literature, mostly from political science, documenting this process (see Bailey, 2010; Braun, 2009 for overviews), the section presents the EU ETS as a product of political contestation within national, EU and international institutions between bureaucrats, governments, industry groups and environmental organisations. The section then delves deeper into primary sources produced by key corporate actors within this contested process. Representations from polluting industry show that appeals to market equality in support of market-based over alternative policies, free allocation of allowances and maximum regulatory coverage, were underpinned by interests in the opportunities afforded by carbon trading to exploit the uneven appropriation of carbon between different actors.

The second section explores how the logic and mechanics of commodification contain the possibility of achieving the goal of exploiting the uneven appropriation of carbon and the extent to which this is realised in the design of the EU ETS. It begins by reviewing the broader critical literature on processes of individuation, privatisation and abstraction in efforts to commodify nature in other areas of what Newell (2008) terms the "marketisation of global environmental governance" (Castree, 2003; Prudham, 2009). These insights are applied in a close analysis of the way the EU ETS Directive structures the commodification of carbon by separating and objectifying general relationships between 'installations' and 'emissions'. The particular installation-emissions relationships included and excluded in carbon allowances are then examined in terms of what differentiated forms of carbon appropriation are equalised in carbon commodities.

Lastly, the third section uses the companies database developed in the previous chapter, and extends it to match companies participating in the EU ETS in a trading-only capacity, to analyse how processes involved in the commodification of carbon condition the impact of the EU ETS on the organisation of emissions. It offers a case study of the carbon allowance trading relationships involving German energy utility RWE, which enabled the largest polluter in the EU ETS to emit greenhouse gases beyond its allocated allowances. The case study illustrates how commodification processes of individuation and abstraction combine to sustain the existing organisation of emissions by enabling big polluting companies such as RWE to exploit differentiation in how, where, what and how much carbon is appropriated by different actors within the EU ETS. A recognition of the limits of internal trading then leads Chapter Five's analysis of the Kyoto mechanisms as an external spatio-temporal fix.

The development of the EU ETS

International, EU and national contexts

The adoption of the EU ETS was particularly noteworthy given the stagnation of EU-level climate policy from the early 1990s, as proposals for energy and carbon taxes were continually frustrated by lack of agreement among national governments. Further, as will be discussed in the next chapter, European Community negotiators had originally opposed US proposals for market mechanisms at the 1997 UN climate conference in Kyoto, before acquiescing to international carbon trading and offsetting mechanisms in order to get an agreement (Christiansen and Wettestad, 2003; Damro and Luaces Méndez, 2003). This shift was shaped by contextual factors at the international, EU and national levels.

At the international level, it has been argued that EU climate policy was pushed towards the market-based agenda following the inclusion of flexible mechanisms in the Kyoto Protocol's emissions reduction framework. Damro and Luaces Méndez (2003: 88–90), for example, argue that despite initial doubts about the market-based approach by European governments, an EU-level carbon market was in fact consistent with the main goals of European negotiators at Kyoto: meeting binding targets, safeguarding the Internal Market project and taking a leading role in international climate policy. EU opposition to emissions trading turned out to be less strong than it first appeared when the synergies between the instrument and the burden sharing arrangements used to distribute responsibility for meeting Kyoto targets between EU countries became evident to European governments (Newell and Paterson, 2010: 100). Finally, once President George W. Bush formally withdrew the US from the Kyoto process in 2001, European countries that were most opposed to the market-based approach were given political space to throw their support behind emissions trading, justified on the basis that it was necessary to ensure the viability of the Kyoto Protocol, which required a minimum share of world emissions to come into force (Skjærseth and Wettestad, 2009: 112–13).

At the EU level, the institutional structure of the EU gave proposals for emissions trading an advantage over taxation. Firstly, under the *Treaty on the Functioning of the European Union*, fiscal matters such as taxation require unanimity from member states in the Council, whereas environmental matters such as emissions trading go through the ordinary legislative procedure of qualified majority support from the Council and Parliament (European Union, 2012b: Article 192). Wettestad (2005: 17–18) argues that while the procedure for taxation empowered states opposed to the measure to block consensus, the procedure for emissions trading forced them to engage constructively in the policy process with a view to extracting concessions, because they could find themselves in a minority position and unable to prevent passage of the legislation.

Secondly, the *Treaty on European Union* makes the Commission the sole EU institution that can propose legislation (European Union, 2012a: Article 17). This placed a market-oriented bureaucracy at the centre of the legislative process. The Commission indeed played an influential role in driving and managing the entire progression of the EU ETS (Wettestad, 2005: 11–15). Its Green Paper set the terms of the debate by drawing heavily on the orthodox economic arguments on the efficiency of carbon markets in achieving emissions reductions at lowest cost. For example, the paper included economic modelling that estimated the costs of meeting emissions targets at €9 billion annually by 2010 without an emissions trading scheme, compared with €6 billion with an emissions trading scheme covering all major sectors (European Commission, 2000b: 27–8). Politically, the Commission set out to build a coalition in favour of emissions trading by convening a working group on flexibility mechanisms involving representatives of different Directorates-General of the Commission, national governments, industry groups and environmental organisations, as well as holding a series of broader stakeholder meetings (European Commission, 2000c, 2001a).

At the member state level, events in the UK, and to a lesser extent Denmark, provided some early impetus towards the EU ETS. As outlined in the Introduction, in the late 1990s, BP, followed by Shell, instituted internal carbon trading systems, which was followed by a limited and voluntary domestic emissions trading system in the UK that commenced in 2002 (Betsill and Hoffmann, 2011: 93). BP's initiative was motivated by opposition to taxation and direct regulation-based climate policies and was intended to demonstrate the viability of national and EU level schemes as an alternative to those options (Victor and House, 2006: 2101). The UK scheme developed out of a proposal from the Emissions Trading Group, formed by BP and made up of oil and gas producers, power companies and energy-intensive manufactures (Bailey and Rupp, 2004: 242; Nye and Owens, 2008: 5–6). Again, the polluting companies were motivated by opposition to taxation and other regulatory measures, initially to the Climate Change Levy, but more importantly, according to Nye and Owens (2008: 10), to the threat of more onerous future policies needed to meet national emissions targets (see also Paterson, 2012: 84–5). The development of the UK scheme hastened the formation of a pro-carbon market coalition of industry at the EU-level and placed pressure on EU institutions to create such a scheme to avoid nationally-fragmented climate policies (Christiansen and Wettestad, 2003: 7; Meckling, 2011: 111; Voß, 2007: 337).

Government, industry and NGO positions

These international, European and national level contextual factors provided supportive conditions for a convergence of governments, industry groups and environmental organisations over support for an EU ETS in general. Within this overall consensus, debate continued to rage over design details such as whether emissions caps would be absolute or relative, whether trading would occur at the installation or member state level and whether emissions liabilities would be incurred upstream or downstream (i.e. point of extraction or pollution) and directly or indirectly (i.e. point of commodity production or consumption). Ultimately, a consensus around a downstream scheme with absolute caps covering the direct emissions of installations emerged in the context of ongoing debates over the coverage of the scheme and the allocation of allowances, which were two of the more intractable issues.

The strongest advocates for a European emissions trading system during initial negotiations were the UK and Denmark, which were setting up national level schemes, along with the Netherlands, Sweden and Ireland (Skjærseth and Wettestad, 2008: 88–91). They were joined by BP, Shell, UK electricity companies and EDF as prominent proponents (Meckling, 2011: 112). Meckling (2011: 104) argues that the pro-carbon trading coalition of industry and government that spread from the UK "acted as Europe's backdoor for emissions trading." They were met with resistance, in particular, from Germany, which initially opposed the idea because it would undermine its domestic system of voluntary climate agreements with industry (Skjærseth and Wettestad, 2008: 92–4). The preference for voluntary agreements reflected the position of most of German industry, especially the electricity and chemicals industries. Energy-intensive manufacturing industries across Europe also tended to oppose a mandatory scheme on competitiveness grounds, arguing that their production would be forced to relocate to countries without a carbon price (Meckling, 2011: 118–20). Resistance was also forthcoming from European environment groups but for contrasting reasons. They started their engagement with the proposed carbon market from the oppositional stance they took on market mechanisms at Kyoto, on the basis that such policies did not mandate sufficient climate action (Meckling, 2011: 114).

Industry opponents of emissions trading were outmanoeuvred by the pro-carbon trading coalition. German power companies were sidelined within the European electricity industry association, EURELECTRIC, and manufacturers such as the steel and chemical industries were too fragmented in their campaigning (Meckling, 2011: 118–9). The majority of electricity generators and oil and gas producers that were in favour of emissions trading were also joined by a rapidly forming carbon trading industry that added political and economic weight to the proposal. Between the signing of the Kyoto Protocol and the passing of the EU ETS Directive, large banks set up carbon trading desks and new boutique carbon trading firms emerged, a pro-carbon market industry organisation in the International Emissions Trading Association (IETA) was founded and number specialty trade conferences and service providers appeared (Newell and Paterson, 2009: 89).

Environmental groups also shifted from opposition to what Meckling (2011: 117) describes as "quality managers" over the environmental effectiveness of emissions trading. This was particularly true of the World Wide Fund for Nature (WWF) and Climate Action Network (CAN) Europe, which were part of the Commission's working group. In the process, these two groups, along with Friends of the Earth Europe, aligned with clean industry groups from renewable energy and energy efficiency-based businesses to counter polluting industries by advocating for stringent rules for any emissions trading scheme alongside a suite of other climate policies (Bokhoven et al., 2001). The gradual shift towards cautious support for emissions trading is reflected in the following statement by CAN Europe, the umbrella group for the mainstream environmental organisations, released in the lead up to the debate on the EU ETS Directive at the Parliament:

> NGOs are generally sceptical of a cap and trade system, as an instrument that is relatively untried on such a scale. However, in view of the wide nature of the emission cuts needed and the lack of other strong EU level policies for heavy industry sectors, most environmental groups have taken a cautiously positive view of this proposal. Yet, unless certain key features are agreed, this system will not be a credible element of the EU's domestic action strategy and NGOs will oppose it (Climate Action Network Europe, 2002).

The three key features nominated by CAN Europe were the need for mandatory participation, that there should be no international linkages with Kyoto mechanisms and that allowances should be auctioned rather than given away for free. International linkages are the focus of the next chapter. The other two features were major points of contention.

Firstly, CAN Europe's advocacy against free allocation found some support from the Parliament, which proposed amendments for enhanced use of auctioning. Relatedly, the Parliament also favoured greater EU control over the quantity and distribution of allowances, rather than devolving the decision to national governments (Skjærseth and Wettestad, 2008: 136). On both issues, Parliament was unable to withstand the weight of member state and industry pressure in favour of decentralised cap setting and free allocation (Skjærseth and Wettestad, 2009: 117). However, the positions of Parliament and CAN Europe were successful in extracting some concessions. In the final Directive, member states had the option to auction a small number – 5 per cent in phase one, 10 per cent in phase two – of allowances and the allocation plans of member states were subject to approval by the Commission on the basis of their consistency with Kyoto targets (European Parliament and Council, 2003: Article 10, Annex III).

Secondly, CAN Europe's call for mandatory participation was in response to the position of the German and UK governments and members of the European Parliament (MEPs), as well as energy intensive industries, especially CEFIC, representing the chemicals industry, and EUROFER, representing the steel industry, for voluntary participation (Economist Intelligence Unit, 2002; European Report, 2002; Markussen and Svendsen, 2005). A voluntary scheme was a second best option for those industries and governments that were least enthusiastic about emissions trading. The UK government, although supportive of emissions trading in general, also preferred a voluntary scheme to begin with because it would be more compatible with its own domestic scheme (Skjærseth and Wettestad, 2008: 108–13). These governments and industries were not fully successful but again received some concessions. Germany achieved the possibility of arrangements where industries could pool their allowances in order to limit trading and thus preserve voluntary agreements. The UK achieved some opt-out provisions for certain installations. Both provisions, however, were agreed to on the basis that their use would be subject to oversight from the Commission, which has limited their usefulness in practice (European Parliament and Council, 2003: Articles 27–8). The chemicals sector lobby was successful in achieving voluntary participation for most of its own members. Process, though not energy, emissions from chemicals manufacturing, as well as the aluminium sector, were excluded from the first two phases of the scheme. The steel industry, however, was included. According to Skjærseth and Wettestad (2008: 124), the Commission and Council pushed for the exclusion of the chemicals sector, despite the opposition from Parliament and NGOs, in order to quell overall

German industry opposition to emissions trading that had been led by the German Chemical Industry Association (VCI).

Creating a "level playing field"

The combination of overall support for emissions trading and ongoing struggles over its design is theorised by Bailey and Maresh (2009) in terms of the competing "regulatory logic" of the instrument's purported cost efficiency and the "territorial logic" of the different actors aiming to defend their own interests. This tension continued following agreement on the EU ETS Directive in the protracted disputes over national allocation plans between states and the Commission and proposals to reform the scheme in later phases (Bailey, 2007: 436–9; Bailey and Maresh, 2009: 451–3). A closer look at the positions of industry on emissions trading in general, and on the issues of allocation and coverage in particular, show that these two logics overlap in interesting ways. In practice, attempts to achieve territorial concessions were part of a two-pronged strategy where the regulatory logic of carbon trading was also used to secure specific corporate interests. The regulatory logic of carbon trading was often framed by polluters in terms of creating a 'level playing field' but their comments reveal an interest in exploiting uneven climate relations.

While sections of industry resisted emissions trading in favour of weaker policy options, fossil fuel-intensive capital was united in preferring the instrument over alternative climate policies. In their summary of submissions to the Green Paper, the Commission stated that energy and carbon taxation was "widely opposed by industry" and that businesses argued they "should be exempt from other policies and measures" in return for supporting emissions trading (European Commission, 2001d: 1, 3). The position is captured by the submission of the European Round Table of Industrialists, which is made up of the CEOs of about 50 of the largest Europe-based multinational corporations. Among them, around the time of the submission, were (prefigurations of) corporations that are top 20 EU ETS polluters, including Total, Iberdrola, E.ON and GDF Suez (Apeldoorn, 2000: 162–3). Appealing to the orthodox economic rationale of efficiency, the organisation asserted that:

> Emissions trading should not be seen as supplemental to existing fiscal measures, or to regulation. To realise the benefits of trading it should be introduced as an alternative to other measures, ensuring that the signals to business are unambiguous (European Round Table of Industrialists, 2001: 2).

The reasons for this are fleshed out in more detail by the Industrial Energy and Power Industry Association (VIK), which represents German energy-intensive industry. While advocating for voluntary agreements, the organisation argued more vehemently against climate policy moving “in the direction of dos and don’ts” and in this context expressed a preference for an emissions trading system where “all considerations are subordinated to the primacy of reducing costs” (VIK, 2001: 6 [translation]). This reluctant support for carbon trading was part of a two-pronged strategy that aimed, if voluntary agreements could not be preserved, to avoid regulatory and taxation approaches that would discriminate between industries and corporations by factoring in issues other than costs, which would violate the goal of the level playing field.

This argument was closely related to the preference for the free allocation of allowances based on historical emissions. The Commission noted that “industry, with only very few exceptions, preferred grandfathering as a method of allocation” (European Commission, 2001d: 3). A central argument against auctioning was a concern for equal treatment between industries. For example, EURELECTRIC, the body representing the European electricity industry, framed their position on allocation in terms of “maximising equity” between companies and “avoid[ing] discrimination” between states (EURELECTRIC, 2000: 6). It argued that the vast majority of allowances should be given away for free because “an auctioning system applicable to all or a large portion of permits could, compared to grandfathering, redistribute costs in an unforeseeable way and risk causing severe economic dislocation” (EURELECTRIC, 2000: 6). This concern with the redistribution of costs makes it clearer that demands for a level the playing field sought to preserve the status quo and therefore, the uneven organisation of emissions. By freely allocating allowances based on historical emissions levels, grandfathering allows established polluting companies to exploit their disproportionate responsibility for climate change.

A similar two-pronged strategy was evident over coverage of the scheme. Following one of its stakeholder meetings, the Commission summarised that "somewhat paradoxically, on allocation industry's main preoccupation was to preserve and enhance a 'level playing field'. This was notwithstanding that the voluntary approach advocated by many could make it harder to ensure this" (European Commission, 2001a: 3). While paradoxical for the Commission, the approach reflected consistent arguments by industry for differentiated treatment for their particular interests and, failing that, equal treatment to protect to their interests more generally. The dual approach was evident in arguments for exemptions from mandatory participation being made alongside arguments for maximum coverage. Industry consensus on the latter was communicated in the final report of the Commission's working group on flexibility mechanisms, which recommended that "a trading system should be designed with a view to extending it to as many sectors, entities and greenhouse gases as possible" (European Commission, 2001c: 5). Despite campaigning, partially successfully, for exemption of its own members, CEFIC maintained, using the regulatory logic of carbon trading, that the scope of the scheme should be as broad as possible. The representatives of the chemicals industry effectively argued that if their industry was required to participate, others should too, stating:

> Flexibility and inclusion of as many sectors as wished are [an] important element of a strategy aiming at the minimization of the overall abatement costs. As [has] been previously noted the greater the number of participating companies the greater the scope for cost effective emissions reductions (CEFIC, 2001: 7).

The steel industry, which was not granted voluntary participation, although would subsequently benefit from favourable levels of free allocation, explained that maximising the scope of the scheme was in the interests of participants because it maximised the potential to source to source allowances from other actors rather than reduce their own emissions. From the perspective of EUROFER, the inclusion of "all relevant sectors, not only [heavy] industry" was necessary because with "energy efficiency close to the theoretical limit" in the steel industry, emissions reductions were "not possible" (EUROFER, 2001: 1–2).

Beyond arguments that emissions reductions were not technically possible, RWE and E.ON drew on the least cost regulatory logic of emissions trading to make it clear why maximising scope was necessary in economic terms. Their joint position advanced the "principle of equality of treatment" by warning that "by only selecting energy-intensive sectors with a *similar* amount of marginal abatement costs, the *heterogeneity* of the trading partners and, consequently, the scope of trading is reduced" (RWE and E.ON, 2001: 2 emphasis added). Hence, maximising the scope of the carbon market was explicitly nominated as useful for large polluters because it increased levels of difference in the forms of carbon appropriation between regulated actors that could be exploited through trading. The political upshot of this position was made clear by the Federation of German Industries (BDI). While the organisation argued for a voluntary scheme, they also favoured maximum scope because "only involving large-scale emitters in the [emissions trading] system throughout the Community would perpetuate the idea that industry is mainly responsible for emissions, apparently diminishing the responsibility of other groups in society" (BDI, 2001: 5). The next sections turns to what, and how, uneven relations are represented in commodify form.

The carbon commodity

Commodifying nature

Carbon markets have emerged in the context of a broader market-based agenda for managing the environment (Newell, 2008). The commodification of nature has been a key theme running through critical analyses of the various attempts to marketise water supply and quality (Bakker, 2003, 2005; Bieler, 2015; Swyngedouw, 2005a), bank wetlands (Robertson, 2000, 2004, 2006, 2007, 2012), rationalise trees and forests (Demeritt, 2001a; Prudham, 2003), patent genes and biotechnology (McAfee, 2003; Prudham, 2007), offset biodiversity and other ecosystem services (McAfee, 1999; Sullivan, 2013), apply fishing quotas (Mansfield, 2004; St Martin, 2005), privatise nature through free trade agreements (McCarthy, 2004) and license wildlife hunting (Robbins and Luginbuhl, 2005), to name just some examples. The various components of commodification have been synthesised directly (Castree, 2003; Prudham, 2009) and indirectly as aspects of the 'neoliberalisation' (Castree, 2008a, 2008b; Heynen et al., 2007; Heynen and Robbins, 2005; McCarthy and Prudham, 2004) or privatisation (Mansfield, 2008) of nature.

The commodification of nature is, of course, a much broader concern than recent attempts at environmental management. The commodity form, though not exclusively capitalist, lies at the heart of capitalist social formations. It is a fundamental to the circulation of value in service of the expanded accumulation of capital – represented by Marx (1976: 256–7) as M-C-M' – where surplus value is produced following the transformation of money into commodities and realised in the retransformation of commodities into more money (Prudham, 2009: 127). The commodification of nature is central to this process. For example, the commodification of land and other natural conditions of life supports the development and maintenance of capitalist class relations that compel workers to sell their labour power as a commodity. The appropriation of carbon also depends on commodified nature when combining labour power and coal, oil, and gas in commodity form in the process of producing commodities such as electricity.

Nonetheless, analysis of the detailed legal and regulatory work of both state and non-state actors that has been required to commodify nature in the literature cited above has systematically uncovered processes of direct relevance to the commodification of carbon. Three key processes highlighted in the literature help unpack how the commodity form affects the relationship between EU ETS and the uneven appropriation of carbon, which Castree (2003) characterises as individuation, privatisation and abstraction.

The commodification of nature firstly requires boundary drawing to separate a relation or substance from its socio-ecological context and objectify it as a distinct thing (Castree, 2003: 280). This physical and/or representational individuation can be seen in efforts to commodify genes. McAfee (2003: 204) argues that patenting genes as “discrete entities” is “reductionist in that it treats nature and its components as quantifiable and as separable, at least conceptually, from their contexts in living nature and society.” Similarly, using the language of wetland banking practitioners, Robertson (2012: 393–4) identifies processes of “unbundling” particular ecosystem services from ecosystems as a whole. The denial of the complex socio-ecological, political, economic production of things like engineered genes and wetland ecosystems is, according to Prudham (2007: 414), a "necessary fiction" for private control over the commodities.

The relationship between commodification and privatisation is a second key concern (Castree, 2003: 279). Bakker (2005: 543) uses the failures of water commodification following privatisation in England and Wales to argue that privatisation is distinct to commodification. The distinction is important and could be made for other commodification processes. For example, Demeritt (2001a) shows how processes of individuation "enframe" forests for use in the statistical records of state resource managers. Privatisation (or individuation) should therefore not be completely reduced to commodification but instead considered as "relational moments in specifically capitalist commodification" (Prudham, 2007: 411). This becomes clearer when privatisation is defined not just in terms of the formal transfer of resources from state or community to private institutional ownership (e.g. Heynen and Robbins, 2005: 6), but any instance of the "creat[ion of] new objects of property" (Mansfield, 2008: 5–6). This is illustrated by McCarthy (2004: 337) in the case free trade agreements. Such agreements have privatised nature not through the direct transfer of ownership, but by creating what is effectively a "brand-new private property right for specific firms" by protecting corporations from any adverse environmental regulation that impinges on profits.

Third, commodities are produced for exchange, which requires a measure of equivalence that abstracts from the particular qualities of individuated and privatised goods and services (Castree, 2003: 281; Prudham, 2009: 125). While money serves this function for commodities in general, markets in environmental management require specific forms of commensuration between objects of regulation that meet specific regulatory goals. Efforts to reproduce the generalised commodity logic for specific environmental commodities have been extensively documented by Robertson in the case of wetlands banking. In these systems, individuated ecosystem services in one location are made commensurable with different ecosystem services in another through the abstraction of "units of incremental ecological function" (Robertson, 2004: 367). This "(scientific) abstraction to functional categories" and "spatial abstraction of already-abstracted functional categories" is necessary to create a very specific form of regulatory equivalence that is germane to carbon trading: trading the degradation of one wetland for the restoration of another (Robertson, 2000: 468).

The remainder of this section explores how states, through the 2003 EU ETS Directive and subsequent amendments, underpin the commodification of carbon by separating, objectifying and equalising uneven social relations with nature. This focus on the role of the state is a common theme in the commodification of nature literature. For example, Bakker (2005: 544) conceptualises commodification as a process of state "reregulation" rather than retreat. However, critical accounts of carbon markets have stressed that too much focus on states gives an incomplete picture of the institutional factors involved in the commodification of carbon (Descheneau and Paterson, 2011; Knox-Hayes, 2010). These broader factors are considered in Part Three of this thesis on the capitalisation of carbon. Analysing the legislative basis of the European carbon commodity, using insights from the commodification of nature literature, builds on and refines existing research that has identified similar processes of commodification in carbon markets. For example, Stephen (2012: 625) argues the carbon commodity must be "qualified," "made commensurable" and "disentangled" and Descheneau (2012) explores similar themes in terms of the logic of money.

The installation-emissions relationship

The process of individuation delimits exactly what is being commodified. The object of commodification in carbon markets is often identified as carbon emissions and/or the carbon cycle. Lohmann (2005: 204, 2011a: 100), for example, refers to the "carbon dump commodity" and the "CO_2 molecules used to build the global warming commodity." The critical literature also makes an important distinction between what is commodified in cap and trade schemes such as the EU ETS and what is commodified in baseline and credit schemes such as the CDM. Paterson and Stripple (2012: 574) understand the former as the commodification of "a right to emit carbon" and the latter as the commodification of "a promise not to emit carbon." Lohmann (2010: 237) expresses the divide similarly in terms of the "commodification of climate benefits/disbenefits."

The social relationships with nature that are commodified in baseline and credit schemes have been more thoroughly analysed compared to cap and trade schemes. Bumpus (2011: 624) contrasts the commodification of “very different material engagements with the atmosphere” in a CDM hydroelectricity project and a voluntary offset market cook-stove project. The differences between the two projects shows that offset credits are commodified representations of the relationship between ‘project’ and ‘avoided emissions’. Lövbrand and Stripple’s (2012) focus on the detailed work involved in producing the carbon credit purchased by one of the authors to offset emissions from air travel also demonstrates that what is being commodified is the relationship between a biomass energy CDM project and the emissions it reduces.

At the same time, and in contrast, Lövbrand and Stripple (2012: 699) argue that the EUA, the carbon commodity of the EU ETS, is “from its inception ‘spatially abstract’.” This is because in offset markets the carbon commodity is built from the project-level up whereas in cap and trade markets “the commodity is invented by fiat of a central authority” (Paterson and Stripple, 2012: 575–6). Lövbrand and Stripple (2012: 699) sum this distinction up in asserting that “in comparison with how offsetting works in the project-based carbon markets, the EUA is not tied to any particular industry installation.” It is nonetheless important to recognise that carbon commodities in cap and trade schemes are still, like in baseline and credit schemes, representations of relationships between entities and carbon pollution. The key relational difference is that carbon allowances in a cap and trade scheme such as the EU ETS are commodified representation of relationships between installations and *actual* emissions, rather than a relationship between a project and avoided emissions. EUAs allow polluters to swap between different forms of carbon appropriation, and thus exploit unevenness in the appropriation of carbon, because they represent relationships between installations and emissions in general. Yet, it is in this process of trading that EUAs do become attached to particular companies and the installation-emissions relationships they control.

The EU ETS Directive codifies the commodification of installation-emissions relationships in its treatment of allowances and the cap. First, the EUA is defined as “an allowance to emit one tonne of carbon dioxide equivalent during a specified period." It is therefore defined in terms of the process of 'emitting', which in turn is defined in relation to the 'installation' as "the release of greenhouse gases into the atmosphere from sources in an installation" (European Parliament and Council, 2014: Article 3). Second, the cap on emissions is selectively applied to these installations. This is achieved through a permit system for the operators of installations administered by national states. Permits both grant "authorisation to emit greenhouse gases from all or part of an installation" and come with "an obligation to surrender allowances…equal to the total emissions of the installation in each calendar year" (European Parliament and Council, 2014: Article 6). This is enforced by a requirement that states ensure "no installation carries out any activity listed in Annex I resulting in emissions specified in relation to that activity unless its operator holds a permit" (European Parliament and Council, 2014: Article 4).

The commodification of carbon in the EU ETS therefore involves processes of both individuation and privatisation. It separates and objectifies installation-emissions relationships from the broader production processes in which they are embedded. This process of individuation is underpinned by a partial privatisation of the climate system that both secures and restricts access to carbon sinks for certain installations. The two aspects of individuation – separation and objectification – underpin the advantages of emissions trading over direct regulation and taxation for the interests of carbon-intensive capital.

Separating installation-emissions relationships from the contexts in which they are embedded excludes regulation of those contextual factors. This was most clearly illustrated in amendments enacted as part of the EU ETS Directive to the Integrated Pollution Prevention and Control (IPPC) Directive, the then primary EU-wide regulatory tool for emissions. The amendments removed any absolute limits imposed by the IPPC on greenhouse gas emissions for installations regulated by the EU ETS (European Parliament and Council, 2014: Article 26). This was necessary because absolute limits for individual installations make allowance trading impossible; the entire rationale of cap and trade systems is that some actors are allowed to increase their emissions provided they can purchase excess allowances from other actors within the overall cap.

In the process the amendments also displaced the regulation of factors other than an installation's emissions. The IPPC, for example, effectively regulates technology standards in production by setting limits that are informed by industry best practice (European Parliament and Council, 2008: Article 1).

Objectifying the installation-emissions relationship as a commodified thing differentiates carbon trading from taxation for polluting capital. The taxation of emissions also requires the separation of the relationship between installation (or similar entity) and emissions. But rather than imposing a charge on the relationship, it becomes something that can be privately controlled. The precise legal and accounting nature of EUAs and other forms of carbon commodities has been a subject of professional and scholarly debate (Lovell, 2013; Manea, 2012). Leaving these debates aside, in regulatory terms, this objectification underpins the potential to exploit the uneven appropriation of carbon by making free allocation and trading of allowances possible.

The separation and objectification of installation-emissions relationships in EUAs didn't totally displace other regulation and or lead to wholly free allocation. Free allocation was the norm in phases one and two but has been reduced since, especially for the electricity sector. The 2020 climate and energy package included Energy Efficiency and Renewable Energy Directives alongside the EU ETS. This illustrates the politically contingent, rather than functionalist, relationship between states and capital. Ongoing contestation over these issues is the subject of Chapter Seven. More importantly for this chapter, conceptualising the carbon commodity in terms of installation-emissions relationships, something that is often overlooked in the existing critical work on the topic, is useful because it recognises carbon allowances as representations of the appropriation of carbon. Following on from Part One's understanding of the production of climate change, the efficacy of the EU ETS can therefore be evaluated by analysing carbon allowance movements as ways of organising the appropriation of carbon.

Equalising (some) difference

The act, and impacts, of carbon trading depend on the forms of abstraction that define the relational substance of the carbon commodity. The forms of carbon appropriation commodified in carbon allowances are determined by the categories of 'installation' and 'emissions'. The EU ETS Directive defines non-aviation installations as "stationary technical unit[s] where one or more activities listed in Annex I are carried out" and measures emissions in terms of "one metric tonne of carbon dioxide (CO_2) or an amount of any other greenhouse gas listed in Annex II with an equivalent global-warming potential" (European Parliament and Council, 2014: Article 3). There is extensive critical analysis on the commensuration of different greenhouse gases but relatively little on the installation side of the relationship.

A range of tools are used to delimit the greenhouse gases, production processes, scales of pollution and production, location and timing included in installation-emissions relationships. Each tool works to equalise different forms of carbon appropriation through types of functional, processual, scalar, spatial and temporal abstraction. At the same time, defining the scope of abstraction also excludes other forms of carbon appropriation from commodification. Table 4.1 highlights the five questions answered by the target, scope, tool and type of abstraction in determining what falls inside and outside the European carbon commodity.

Table 4.1: EUA abstraction

Question	**Target**	**Scope**	**Tool**	**Type**
What?	Greenhouse gas	CO_2, N_2O, PFCs, other opted-in	Global warming potential	Functional
How?	Production process	Primarily electricity and manufacturing sectors	List of 'activities'	Processual
How much?	Installation size	No absolute minimum	Capacity and output thresholds/opt-out provisions	Scalar
Where?	Location	Member states of the EU plus Norway, Iceland, Lichtenstein	EU treaties	Spatial
When?	Timing	2005-2007 (phase 1) 2008-onwards (phases 2, 3…)	Banking and borrowing	Temporal

The tool of 'global warming potential' (GWP) abstracts from *what* greenhouse gases are included in commodified installation-emission relationships. GWP makes the different greenhouse gases emitted from installations equivalent by comparing their contribution to climate change over a certain period of time. The attempt to measure greenhouse gases in terms of their climate impacts makes GWP a form of functional abstraction. The tool has a scientific and political history that is prior to the direct history of carbon markets. The notion of GWP was developed by scientists, primarily working within the Intergovernmental Panel on Climate Change (IPCC), in response to the need for a single measure of climate impact that could structure both climate models and global climate agreements (Paterson and Stripple, 2012: 571). Its use in these areas, and in carbon markets, has also been criticised for the significant uncertainties, the arbitrariness of the 100-year time period commonly used, the reductionism of measuring climate impacts in terms of 'radiative forcing' alone and the erasing of the history of cumulative emissions (Demeritt, 2001b: 316–17; Frame, 2011: 142; MacKenzie, 2009: 446).

Despite calls from industry for all six Kyoto Protocol greenhouse gases to be included, for largely practical reasons the EU ETS was limited to carbon dioxide in the first phase (European Parliament and Council, 2014: Annex I). From 2008, states could also opt-in other gases, which was taken up for N_2O by the Netherlands, Italy, United Kingdom, Austria and Norway (European Commission, 2015b; European Parliament and Council, 2014: Article 24). The original Directive did also declare an intention to include further gases and this was realised from phase three, with amendments that mandatorily included N_2O from the chemicals sector and PFCs from the aluminium sector (European Parliament and Council, 2014: Annex I). GWPs equalise in commodity form these various gases with considerably different climate impacts; EU ETS regulations assign GWPs that make one tonne of N_2O, or one tonne of the two relevant PFCs, tetrafluoromethane and hexafluoroethane, equal to 298, 7,390 and 12,200 tonnes of CO_2, respectively, over a 100 year period (European Commission, 2014f).

The relatively limited scope of gases regulated by the EU ETS makes other types of abstraction, on the installation side of the commodified relationship, more significant. The list of activities in Annex I of the EU ETS Directive is the tool that abstracts from *how* different production processes constitute installation-emissions relationships. In the first phase, this tool set the scope of processual abstraction to include combustion, oil refining, coke ovens, metal ore roasting and sintering, steel production, cement production, glass manufacturing, ceramic firing, and pulp, paper and board production. As flagged above, while originally excluded, various activities from the chemicals and aluminium sectors along with carbon capture and storage, were ultimately included from 2013, but other production processes such as transport remain excluded, to make a total of 25 stationary activities (European Parliament and Council, 2014: Annex I). Different production processes also appropriate carbon in highly uneven ways. For the EU ETS as a whole, 73 per cent of 2005-12 emissions were from combustion installations, 21 per cent were from cement, oil refining and iron installations, while the other 20[4] activities, plus other-opted in installations, accounted for just 5 per cent of emissions. A sectoral breakdown reveals that combustion installations are dominated by electricity and gas supply installations, which account for 65 per cent of emissions (see Table 9.3 and Table 9.4 in the Appendix).

The installation sizes captured within EUAs are determined by capacity and production thresholds as well as limited opt-out provisions, which set the scope of scaler abstraction for *how much* pollution is released overall in relationships between installations and emissions. For combustion installations, a capacity threshold is set at 20MW of installed capacity, which was an increase in the scope of the scheme from the Commission's original proposal for 50MW (European Commission, 2000b: 14). Thresholds for other activities are expressed in terms of production output, such as more than 2.5 tonnes of production per hour for steel installations. Other activities, such as mineral oil refining, have no thresholds at all (European Parliament and Council, 2014: Annex I). The amended Directive also allows states to opt-out installations emitting less than 25Kt of CO_2-e per year each year (European Parliament and Council, 2014: Article 27). As shown in Chapter Three, the majority of installations release less than 25Kt of CO_2-e per year, indicating opt-out provisions have not been utilised in many cases. The prevalence of 'mini' installations suggests the tools of capacity and output thresholds produce a high level of scalar abstraction. This is evident when

[4] Lime production is now one of 25 separate activities but included within cement here, to make a total of 24, due to reporting discrepancies from the European Commission that prevent full a breakdown of lime production within the cement activity.

different levels of installed capacity in combustion installations are compared. The 20MW threshold is 0.3 per cent as large as the of 5,400MW installed capacity of the Bełchatów power plant, the largest polluting installation in the EU ETS (PGE Group, 2015b).

The location of *where* commodified installation-emissions relationships occur is a product of the broader political economy of European integration and expansion, rather than particular struggles over the coverage of the EU ETS (see Bieler and Morton, 2001; Bonefeld, 2001). All EU member states are automatically part of the EU ETS, while Iceland, Norway and Lichtenstein, joined in phase two through their membership of the European Economic Area. The tool of spatial abstraction is the EU ETS Directive requirement that states ensure "allowances issued by a competent authority of another Member State are recognised for the purpose…of meeting an operator's obligations," which is backed up by EU law that makes Directives binding on member states (European Parliament and Council, 2014: Article 12; European Union, 2012b: Article 288). The geographical scope of the EU ETS expanded significantly with the accession to the EU of new member states, mostly in Central and Eastern Europe, from 2004. This added countries with both high absolute emissions, such as Poland (the fourth highest in the EU ETS) and high per capita emissions, such as Estonia (the second highest in the EU). Overall, however, new EU members are more likely to be below average in terms of both absolute and per capita emissions (European Environment Agency, 2015). Thus, the level of difference in absolute and per capita emissions between states equalised in the carbon commodity was also increased with the accession of new member states.

Lastly, banking and borrowing provisions in the Directive are tools of temporal abstraction for *when* installation-emissions relationships occur. The tools allow operators of installations to keep current allowances for future use and draw on future allowances for current use. The latter is possible because allowances are allocated each year before the deadline for surrendering allowances for the previous year's emissions, which means operators of installations have the next year's allocation in their possession at compliance time (European Parliament and Council, 2014: Articles 11 and 12). Despite industry calls for maximum flexibility, banking and borrowing was restricted in phase one to between years (2005-07) in that phase (European Parliament and Council, 2003: Article 13). From phase two, banking and borrowing was extended by amendments that require unused allowances to be reissued in each new phase, thus indefinitely extending the effective eligibility of allowances for surrendering (European Commission, 2014m: Article 13). Therefore, increasingly, the carbon commodity has made installation-emissions relationships in one year equivalent to installation-emissions relationships in other years. Yet, year-to-year, the conditions determining emissions levels also differ. The clearest example of this is that in the depths of the economic crisis in 2009, when controlled for new entrants, EU ETS emissions fell 11 per cent from 2008 levels (European Environment Agency, 2015). Yet, York (2012: 163) has shown that "history matters" for when greenhouses gases are emitted by demonstrating a non-linear relationship between economic activity and emissions, which reduce less in times of economic crisis than they increase in times of growth. The following section looks at how the equalisation of different relations with nature in commodity form is exploited through the trading of carbon allowances.

Trading carbon allowances

RWE's internal and external allowance trading

This section analyses the trading of carbon allowances through a case study of German energy utility RWE, the ultimate owner with both the highest 2005-12 verified emissions and the largest allowance allocation deficit. RWE shares common characteristics with most of the other ultimate owners with the ten largest allowance deficits identified in Table 4.2. All of the ultimate owners identified in the table primarily pollute in the electricity and gas supply sector, except the Government of Norway, which produces the majority of its emissions in the oil and gas mining industry by virtue of its ownership of Statoil. Nonetheless, Statoil's EU ETS emissions are the result of similar combustion processes for energy production, rather than extraction process emissions, which are not covered by the EU ETS. Each of the 10 owners with the largest allowance deficit is in the top 20 overall polluters, except Gas Natural and the Government of Norway, which are the 26th and 43rd largest polluters, respectively. The Government of Norway's deficit was also greater than its allocation because 24 of its 28 Norwegian installations were awarded no free allowances, an outlier compared to all other states. Apart from the Government of Norway and Drax Group, free allowance allocations still covered the majority of emissions for each of the top ten deficit holders.

Table 4.2: Top 10 2005-12 allowance deficits by ultimate owner

Ultimate owner	05-12 allowance deficit (Mt CO_2-e)	Percentage of 05-12 allocation
RWE AG	237	29%
Government of Sweden	159	27%
E.ON SE	112	17%
Enel SpA	91	16%
Drax Group plc	83	91%
GDF Suez	58	15%
Government of Norway	43	168%
Government of France	42	9%
Iberdrola SA	41	24%
Gas Natural SDG SA	37	49%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

RWE's overall deficit of 237Mt CO_2-e, representing just over a quarter of its overall allocation, could be closed in three ways: (1) by bidding for allowances in open auctions, (2) sourcing offset credits from CDM and JI projects or (3) purchasing allowances from other privately and publicly owned corporations regulated by the EU ETS. As noted above, auctioning was limited to 5 and 10 per cent of allowances in the first two phases of the EU ETS, respectively. In practice, states only reserved 0.13 and 3 per cent of allowances for auction in their phase one and two national allocation plans, which limited the potential of the first option (Ellerman et al., 2010: 62). The second option, the sourcing of carbon credits from the CDM and JI, is the focus of the next chapter. This section focuses on option three, which was the method primarily used by RWE to meet the gap between its free allocation and verified emissions. In total RWE covered 212Mt CO_2-e of pollution above its allocation, representing 89 per cent of its allowance deficit, by surrendering EUAs. This was the most EUAs surrendered by any ultimate owner in excess of their free allocation, which means a case study of RWE – important in its own right as a major polluter – provides the most empirical scope to explore trading activity that is internal to the EU ETS.

Physical trading – actual transfers of carbon commodities – of both carbon allowances and carbon offset credits between different types of accounts is logged by the European Union Transaction Log (EUTL) (European Commission, 2014i). The two noteworthy types of accounts are 'operator holding accounts', which are linked to installations, and 'person holding accounts', which are trading-only accounts that may be controlled by polluting companies or purely financial actors. The matching process outlined in Chapter Three and the Appendix has been extended to also match person holding accounts with their owners, in order to provide a fuller picture of the corporate actors involved in EUA trading. There is a three year delay on the release of transaction information and therefore, at the time of writing, the trading information is available until 30 April 2011, which encompasses the full first phase and three out of five years of the second phase of the EU ETS (European Commission, 2013c).

RWE's installation accounts purchased 286Mt CO_2-e worth of allowances and offset credits during the period for which trading data is available. Almost all (93%) were acquired internally by accounts owned by RWE, as shown in Table 4.3. The 6 per cent from steel corporations HKM and ThyssenKrupp are also effectively internally acquired because they are allowances passed on to RWE as part of waste gas transfer agreements between the companies (Elsworth et al., 2011).

Table 4.3: Sources of allowances and credits acquired by RWE installations

Ultimate Owner	**Allowances and credits (Mt CO_2-e)**	**Percentage of total acquired**
RWE AG	266	93%
HKM GmbH	10	3%
Thyssenkrupp AG	9	3%
EnBW AG	2	1%
Others[5]	0.1	0.02%
Total	286	100%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

[5] Includes: Consus sp zoo, Mol Magyar Olaj-es Gazipari Rt, Government Of the Czech Republic, BP plc, Vertis Zrt, NET4GAS Holdings sro, Exxon Mobil Corp.

The largest supplier of credits acquired by RWE installation accounts was accounts controlled by RWE Supply & Trading, RWE's specialised energy trading desk, which also engages in power, gas, coal, freight, oil, weather and renewable energy certificate trading. RWE Supply & Trading's carbon market involvement extends beyond internal compliance to third party trading of spot and futures contracts, EUA-CER swaps and sourcing CERs from CDM projects (RWE Supply & Trading, 2014). It is the trading activity of trading accounts, such as those controlled by RWE Supply & Trading, that is most relevant in discovering the external sources of allowances surrendered by RWE installations because it is those accounts, rather than installation accounts, that mostly trade outside the boundaries of the corporation.

Table 4.4: Top external sources for RWE trading-only accounts

Ultimate owner	**Allowances and credits (Mt CO_2-e) sold to RWE**	**Percentage RWE's externally acquired allowances and credits**
RHJ International SA	32	11%
UBS AG	30	10%
NYSE Euronext Inc	26	9%
Deutsche Börse AG	24	8%
Government of Sweden	19	6%
Barclays plc	18	6%
E.ON SE	18	6%
Government of France	17	6%
Bank of America Corporation	10	3%
GDF Suez	9	3%
BNP Paribas	7	2%
Centrica plc	7	2%
EnBW AG	7	2%
KSBG GmbH & Co KG	6	2%
Morgan Stanley	5	2%
BP plc	5	2%
Royal Dutch Shell plc	4	1%
NASDAQ OMX Group Inc	3	1%
Cargill & Macmillan Families	3	1%
Government of the Czech Republic	3	1%

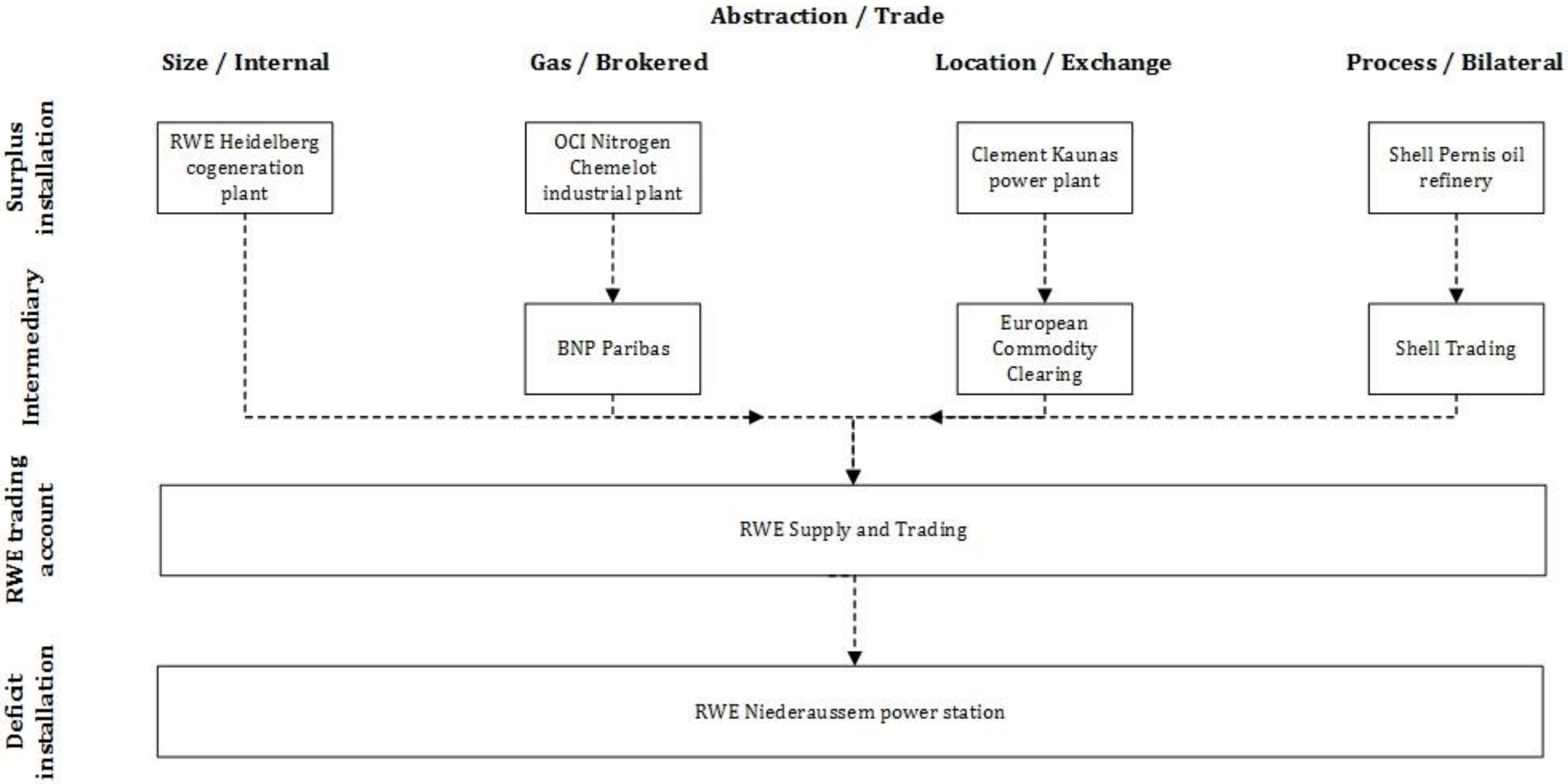
Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 4.4 shows the top 20 external ultimate owners that RWE's person holding accounts (i.e. trading only) acquired carbon commodities from. Half are financial institutions that either provide carbon exchange platforms or actively engage in carbon trading, and half are polluting companies with substantial financial operations. NYSE Euronext, Deutsche Börse and NASDAQ OMX own or owned the carbon exchanges Bluenext (closed in 2012), European Energy Exchange (EEX) and NASDAQ OMX Commodities Europe (previously known as Nord Pool), respectively. RHJ International, UBS, Barclays, the Bank of America, BNP Paribas and Morgan Stanley are financial institutions that engage directly in carbon trading on behalf of clients and/or for their own gain. The broader financial activities of these actors are the subject of Chapter Six. This section charts their role as intermediaries between installations. The presence of some the biggest polluting ultimate owners in the EU ETS in the top 20 suppliers to RWE, despite many of them appearing in the top ten deficit holders, is reflective not of their surpluses, but rather of the financialisation of E.ON, GDF Suez, EDF and Vattenfall.

Reconstructing EUA commodity flows

This case study evaluates the efficacy of the EU ETS by comparing the different forms of carbon appropriation that are substituted in trading relationships within RWE, and between RWE and third parties via intermediaries that are listed above. The analysis redresses a lacuna in the existing critical literature on carbon markets, which has given insufficient empirical attention of specific trading relationships within the EU ETS. Due to limitations in the available data, commodity flows can only be reconstructed rather than precisely mapped. It is not possible to trace an individual carbon allowance across multiple trades to its ultimate surrender because unique EUA serial numbers were hidden from public view in the EUTL following security breaches that are briefly discussed in Chapter Six. The data does, however, permit the existence of trading relationships between accounts to be established, including when and how many EUAs were transferred, enabling the reconstruction of commodity flows. While the case study is therefore necessarily illustrative, it is these trading relationships, as instances where different social relationships with nature are substituted, that are important in evaluating the efficacy of the EU ETS in challenging existing patterns of carbon appropriation.

Figure 4.1: RWE EUA commodity flows



The case study is organised according to four examples that each highlight one form of commodity abstraction and one basic method of trading featuring the internal and external actors identified. The first involves scalar abstraction between different installation sizes with an example of internal trading from a medium-sized installation owned by RWE. Then it moves on to functional abstraction between different greenhouse gases with an example of broker-mediated trading involving BNP Paribas and a nitrous oxide installation. Following this, spatial abstraction between countries is illustrated with an example of an exchange-mediated trade involving EEX and a Lithuanian installation. Lastly, a bilateral trade between polluters, from Shell's energy desk, on behalf of its own oil refinery shows processual abstraction between different production methods. The hiding of EUA serial numbers and the short period of available data prevents an example of temporal abstraction, but the financial significance of this form of abstraction is discussed in Chapter Six. The different forms of abstraction and types of trade at different stages of these reconstructed EUA commodity flows are illustrated in Figure 4.1.

As shown in the final stage of the commodity flow figure, the extent to which unevenness between different pollution scales, greenhouse gases, locations and production processes in commodified installation-emissions relationships sourced by RWE could be exploited is illustrated by comparing them with the company's Niederaussem power plant. As RWE's largest installation, the Niederaussem power plant also had RWE's largest single allowance deficit of 63,244,650t CO_2-e. This represented 39 per cent of its total allocation and the deficit was closed entirely by surrendering EUAs. In the period for which trading data is available, the Niederaussem power plant sourced 90 per cent of the allowances it acquired from RWE trading only accounts (European Commission, 2014i).

RWE's allowance trading relationships

Although RWE's overall deficit meant the company needed to buy allowances from other companies, its deficit installations could also trade internally in order to surrender allowances from RWE installations with surpluses. Table 4.5 breaks down the surpluses and deficits of RWE's installations according to installation size. It shows that

RWE's 74 zero, mini, small and medium-sized installations had a net surplus of allowances while the company's 24 large installations had a net deficit. This replicates the pattern in the broader companies database, also shown in Table 4.5. RWE's internal trading between installation-emissions relationships differentiated by polluting scales is therefore illustrative of the exploitation of the uneven appropriation of carbon in the EU ETS as a whole.

Table 4.5: RWE and EU ETS 2005-12 allowance surplus/deficits by installation size

Installation size	**RWE installations**	**RWE 05-12 surplus/deficit (Mt CO_2-e)**	**EU ETS installations**	**EU ETS 05-12 surplus/deficit (Mt CO_2-e)**
Zero	3	0.05	855	35
Mini	36	1	5,333	127
Small	8	0.4	1,530	103
Medium	27	9	2,281	408
Large	24	-247	939	-369
Total	98	-237	10,938	304

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

RWE's own Heidelberg cogeneration plant, which provides heat, steam and cooling for Heidelberg Hospital, Germany, recorded an allocation surplus each year between 2005 and 2012 for a total phase one and two surplus of 104,811 allowances (RWE Innogy, 2014). This surplus was further extended by the 84,416 CERs the installation surrendered between 2005 and 2012. It transferred a total of 94,298 allowances in the period for which transaction logs are available to other trading accounts owned by RWE (European Commission, 2014i). The plant's maximum yearly verified emissions of 73,394t CO_2-e in 2010 places it at the smaller end of medium-sized installations, which release between 50,000t and 500,000t CO_2-e per year. The commodification of carbon therefore allowed RWE to substitute between an installation-emissions relationship at the 2590th biggest polluter in the companies database for an installation-emissions relationship at the second biggest overall polluter. To put this in perspective, the Heidelberg cogeneration plant's maximum emissions represent 0.2 per cent of the maximum 31,252,670t CO_2-e released by the Niederaussem power plant in 2007.

However, RWE's non-large sized installations covered only 4 per cent of the deficit of large-sized installations, limiting the potential for internal trading of this kind.

The potential for RWE to meet its deficit by substituting between greenhouse gases by trading with other companies during the period for which transaction data is available was limited to the ten nitrous oxide emitting installations opted-in by the governments of the Netherlands, Austria, Norway, the UK and Italy (European Commission, 2015b).[6] The opted-in installations were also granted a substantial allowance surplus. In 2012 – the year by which they had all been opted-in – the nitrous oxide emitting installations registered a surplus of 2,785,231 EUAs, representing 41 per cent of their total allocation.

The three Dutch installations were the first to be opted-in from the beginning of phase two. One of them was the Chemelot industrial chemical park at Geleen, the Netherlands, operated jointly by a number of companies including OCI Nitrogen that produce nitric acid, which is used in the production of ammonia and fertiliser (Chemelot, 2014). The park was already an EU ETS installation for its carbon dioxide emissions, but the inclusion of nitrous oxide emissions was rewarded, based on the benchmarking of historical emissions, with an increased allocation of 1,607,512 allowances over the course of phase two, accounting for over half of the installation's 2008-12 surplus of 3,396,434t CO_2-e (European Commission, 2008, 2009a).

The connection between RWE and Chemelot is via the carbon brokering activities of a financial institution. Following the opt-in of nitrous oxide, the installation's account sold allowances totalling 71,500t CO_2-e to French investment bank BNP Paribas between November 2010 and April 2011 (European Commission, 2014i). BNP Paribas operates as a carbon trader both for proprietary gain and on behalf of clients and is the 11th highest external supplier of carbon commodities to RWE (BNP Paribas Corporate and Investment Banking, 2014). Chemelot's surplus allowances freed up part of the 155,000 allowances BNP Paribus sold to RWE's trading desk RWE Supply & Trading, over the same period (European Commission, 2014i). In doing so, RWE could exploit

[6] Installation numbers: Italy (1252, 1253), Norway (109, 110), Austria (236) UK (148, 194), Netherlands (107, 128, 298).

differentiation in the GWPs of carbon dioxide – the only greenhouse gas the Niederaussem power plant is regulated for under the EU ETS – and nitrous oxide. While the latter's GWP of 298 indicates the relative potency of any given tonne of N_2O vis-à-vis CO_2, carbon dioxide accounted for 82 per cent of total CO_2-e emissions across the EU in 2012, compared with 7 per cent for nitrous oxide (European Environment Agency, 2014a: 11). Thus, RWE was also exploiting unevenness in the overall contribution of different gases to the production of climate change.

The Chemelot example combines functional with spatial abstraction across countries. Spatial abstraction is most evident in the standardised emissions contracts sold by financial institutions providing carbon exchange services – what Paterson and Stripple (2012: 578) describe as "Walmart" carbon. As outlined above, RWE's fourth largest supplier of carbon commodities was Deutsche Börse, which owns EEX and its subsidiary clearing house European Commodity Clearing (European Commodity Clearing, 2014). European Commodity Clearing sold 24,146,225 credits to RWE between April 2005 and December 2010. The number of different countries that the allowances in this single trade were originally allocated in – 13 countries, including Germany, Lithuania, the Netherlands, Czech Republic, UK, Slovakia, Poland, Portugal, Denmark, Sweden, Spain, Italy and Luxemburg – shows the extent of spatial abstraction involved in exchange-mediated trades (European Commission, 2014i).

The 140,000 Lithuanian allowances European Commodity Clearing acquired in December 2005 were from the Kaunas Combined Heat and Power Plant, currently owned by US company Clement Power Venture (European Commission, 2014i). The Kaunas plant's 2005-12 surplus of 1,379,324 allowances, representing 25 per cent of its total free allocation, was indicative of a general pattern of over-allocation in Lithuania. The country had an overall surplus of 21Mt CO_2-e in phase one and two, representing 32 per cent of its total free allocation recorded in the companies database. This translated to the ninth largest EU ETS surplus in absolute terms, and the fourth largest relative to allocation, despite being the fifth smallest overall emitting country. Again, to place this in perspective, between 2005 and 2012, RWE's Niederaussem power plant alone released over four times more emissions than all of Lithuania's installations combined.

The Kaunas plant's surplus, just one of the many instances of over-allocation that made European Commodity Clearing's sale of allowances to RWE possible, was a product of the uneven historical development of Lithuania. As with other former communist countries, Lithuania's transition to market capitalism was characterised by a rapid deindustrialisation. As a result, between 2008 and 2012, Lithuania's total greenhouse gas emissions (both EU ETS and non-EU ETS sectors) were 47 per cent below their Kyoto target, which is set relative to a 1990 baseline (European Environment Agency, 2013b: 50). Along with an erroneous projected increase in emissions that didn't materialise following the closure of a nuclear power plant, the situation allowed the Lithuanian government to allocate a quantity of allowances that sanctioned an increase in Lithuania's EU ETS emissions but still be on track to meet its Kyoto targets (Bubnienė, 2008; Jaraitė and Di Maria, 2014). The sale of the Kaunas installation's surplus benefited its owner financially but it also contributed to the maintenance of emissions by RWE installations. RWE was able to exploit, for example, differentiation in the per capita emissions of Germany and Lithuania; in 2012 the former released 12 tonnes of CO2-e per capita compared with 7 tonnes of CO2-e per capita in the latter (European Environment Agency, 2015). The equalisation of these differences in commodity form is most evident when compared to North Rhine-Westphalia, the state where the Niederaussem power plant is located, which has per capita emissions of almost twice the German average and therefore over three times higher than Lithuania's (Energie Agentur NRW, 2010).

Lastly, RWE's trading relationship with Shell illustrates both the potential to trade between differentiated production processes and a form of bilateral trading between polluters. Shell is involved in the EU ETS as both the owner of 15 installations – oil refineries and associated power plants – and as a major carbon trader through its Shell Trading energy desk (Shell Global, 2015). The 4,279,000 allowances and credits Shell sold to RWE could therefore have been drawn from its own 2005-12 surplus allocation of 13,508,784 tonnes and/or external trading activity (European Commission, 2014i). Over half of Shell's surplus, totalling 7,464,684 allowances, was from a single installation, the Pernis oil refinery in Rotterdam, the Netherlands. The refinery, the largest in Europe and the 69th biggest polluting installation in the EU ETS, produces 404 thousand barrels of crude oil per day and transferred a total of 6,906,915 allowances to

Shell Trading accounts between April 2005 and April 2011 (European Commission, 2014i; Shell Netherlands, 2015).

The majority of on-site emissions from oil refineries such as Pernis are from various chemical reactions, which is quite different to emissions from the combustion of fossil fuels in the Niederaussem power plant (Ecofys, 2009b: 4). Pernis' allowance allocation surplus was largely a product of perceived differences in market conditions that embed these production processes. Governments over-allocated oil refinery installations, as well as cement, steel and most other activities, because they were deemed exposed to international competition in a way that combustion installations in the electricity industry are not (Ellerman and Buchner, 2007: 74–5; Wettestad, 2009: 309–10). Between 2005 and 12, the mineral oil refining activity had the third greatest surplus after steel and then cement.

A comparison of the substitution of installation-emissions relationships at Pernis for Niederaussem illustrates how commodification processes can entrench, rather than challenge, patterns of carbon appropriation. Even if Pernis' surplus was a result of Shell's reported efforts to reduce energy and process emissions at the plant in recent years, this is not equivalent to actions that could have been taken by RWE to reduce the Niederaussem power plant's emissions (Royal Dutch Shell, 2012; Shell Global, 2008). Reducing emissions in the process of producing fossil fuels – oil products such as those made by Pernis are major sources of carbon pollution in the transport and agriculture sectors outside the EU ETS – doesn't represent a shift away from carbon-intensive forms of capital accumulation. RWE reducing an equivalent quantity of emissions by replacing electricity generated at Niederaussem with renewable energy, or working with consumers to reduce their demand would, however, represent a path away from an economy based on the appropriation of carbon, because it would challenge to the centralised fossil fuel-based electricity generation model (Unruh, 2002). Therefore, the problems identified with the orthodox economic conception of emissions reductions in analytical assessments of carbon markets are reproduced in the actual functioning of carbon markets by processes of commodification.

Conclusion

This chapter has built on Part One of the thesis by demonstrating that the uneven appropriation of carbon between polluting corporations in the EU ETS is underpinned by multiple axes of internal differentiation. In addition to the scale of polluting activity, as represented by installation size, which was highlighted in Chapter Three, these include the location, timing and production processes involved. Processes of commodification represent the appropriation of carbon in EUAs by separating and objectifying relationships between installations and emissions and equalising difference between them. By commodifying carbon in this way, polluting corporations can exploit internal differentiation by substituting one form of carbon appropriation for another in order to pollute above levels of free allocation. As the EU ETS has developed, levels of free allocation have contracted while the scope of the scheme has expanded, making substitution via commodity trading increasingly important.

The RWE case study illustrates how allocation and trading practices in the EU ETS can maintain the existing patterns of carbon appropriation and therefore fail to effectively address the production of climate change. Indeed, the Niederaussem plant, which was included to illustrate how the exploitation of differentiation enables this, maintained its emissions within a small band above and below 2005 levels throughout phase one and two. Buying allowances to sustain emissions aligns with RWE's corporate strategy of defending its existing fossil fuel generation assets rather than investing in renewables (Bontrup and Marquardt, 2015). The strategy is reflected in the very low share of renewable energy in RWE Generation's – the part of the company that operates in its main markets of Germany, the UK and the Netherlands – asset portfolio. In 2013, only 2 per cent of the electricity produced by RWE Generation was produced with renewables, compared to 81 per cent for fossil fuels (RWE, 2014a: 25). This is well below the average share of renewables in electricity production in each country, which in 2013 was 26 per cent in Germany, 14 per cent in the UK, and 10 per cent in the Netherlands (Eurostat, 2015). RWE's Chief Executive, Peter Terium, has acknowledged this poor record in saying "we were late entering into the renewables market – possibly too late" (Steitz, 2014). The carbon market is just one of the many factors that influence such decisions, including other climate and energy policies, fuel and electricity prices, general economic conditions and community pressures. Studies of the investment and innovation effects of the EU ETS have concluded that these other factors have been consistently more important that the carbon price (Hervé-Mignucci, 2011: 36; Hoffmann, 2007: 468–9; Rogge, Schmidt, et al., 2011: 3–4; Rogge, Schneider, et al., 2011: 518). But the processes of carbon commodification at the core of the EU ETS allow significant corporate polluters with large-scale fossil fuel infrastructure, such as RWE, to navigate these factors in ways that maintain existing patterns of carbon appropriation, because the carbon market creates no obligation to reduce emissions.

The orthodox economic logic that provides the policy rationale for the EU ETS is neutral on what, how, how much, when or where RWE, or any other regulated entity pollutes provided it is within the overall cap. Conversely, it has been argued in this chapter that the internal differentiation equalised in commodity form is reflective of uneven contributions to the production of climate change. For this reason, emissions reductions in each of the installations linked to RWE through trading relationships with intermediaries do not represent actions that would address the production of climate change as effectively as if the Niederaussem power plant reduced its own emissions. This is because, compared with the installations that sold allowances, the Niederaussem power plant is responsible for a larger scale of emissions, of a more prevalent greenhouse gas, in a location with higher absolute and per capita emissions, and through a production process that is closer to the core of the organisation of emissions in the EU ETS. The point is not that reducing the appropriation of carbon at the other end of RWE's trading relationships is not important or necessary, but instead to question whether such actions should be able to maintain the emissions of Europe's largest polluter.

This question has not been fully answered despite the extensive work done on equivalences between greenhouse gases in carbon markets. MacKenzie (2009) focuses on the act of "making things the same" in carbon markets but does not consider whether the carbon commodities are indeed the same in climate terms. Similarly, Lohmann (2011b: 102–3) expresses "the endless algebra of climate markets" through a series of equations such as "CO_2 reduction through technology A = CO_2 reduction through technology B" and "CO_2 reduction in place A = CO_2 reduction in place B." However, the critique of the incommensurability of the equations that follows is largely limited to epistemological problems of calculation and quantification rather than concrete effects.

RWE's reconstructed commodity flows illustrate how the EU ETS can engender the substitution of more marginal for more transformative efforts to address climate change. Returning to this chapter's research question, the EU ETS risks entrenching the existing organisation of emissions, limiting its capacity to operate as an efficacious policy in addressing the production of climate change. A fuller exploration of the effects of carbon commodification on the efficacy of the EU ETS first requires consideration of its links with the Kyoto mechanisms, which are addressed in Chapter Five.

5 – Kyoto's external fix

Introduction

Opportunities to exploit differentiated forms of carbon appropriation are not limited to the relationships between installations and emissions that are commodified within the EU ETS. Since 2008, European carbon allowances have been supplemented by carbon credits produced in offset projects that are part of the Kyoto Protocol's 'flexibility mechanisms'. This chapter focuses on the commodification of relationships between offset projects and emissions *reductions* that are external to the EU ETS and the 'fix' they provide for companies within the EU ETS. Although the history of the Kyoto mechanisms predates that of the EU ETS, the analysis of the CDM and JI in this chapter is developed out of an understanding of the limits to the internal trading discussed in Chapter Four. The purpose of the approach is to continue the evaluation of the socio-ecological efficacy of the EU ETS that began in the previous chapter. Therefore, it is primarily concerned with the impact of the Kyoto mechanisms on the organisation of emissions in the EU ETS. Analysing the Kyoto mechanisms in terms of their relationship to the EU ETS is warranted because, following their initial development, the evolution of the CDM and JI has been driven by the links between the markets.

The weight of critical research on the Kyoto mechanisms evaluates the impacts of the CDM, and to a lesser extent JI, as distinct objects of analysis, rather than focusing on their links with the EU ETS. There is an extensive critical literature with strong ties to radical movements on the negative local impacts of offset projects. This literature has highlighted problems including the dispossession of land, the absence of community consent and ecological degradation from unsustainable practices (Böhm and Dabhi, 2009; Bond and Dada, 2007; Ghosh and Sahu, 2011; Gilbertson and Reyes, 2009; Lohmann, 2006). The generation of offset credits for use by government and corporations in the global North at the expense of local communities and ecosystems in the South has been theorised in neo-imperial terms as "carbon colonialism" and "new enclosures" (Bachram, 2004; Bond, 2012). Böhm et al. (2012: 1631) add nuance to this argument by emphasising the active role of "Southern elites" in advocating for offset markets. The question of the local impacts of offset projects is directly relevant to the institutional structure of the CDM because the Kyoto Protocol states that the instrument should both help developed countries meet their emissions targets and promote sustainable development in developing countries (UNFCCC, 1997: Article 12). Reviews of the governance of sustainable development in the CDM, which draw on a wealth of case study work, have mostly agreed that the goal has not been delivered (Boyd et al., 2009; Bumpus and Cole, 2010; Corbera and Friedli, 2012; Liverman, 2010; Newell et al., 2009; Olsen, 2007; Olsen and Fenhann, 2008; Phillips et al., 2013; Schneider, 2007; Sutter and Parreño, 2007) while highlighting some project types that have delivered, or promise, better outcomes (Lovell and Liverman, 2010; Simon et al., 2012).

The literature on the local impacts of offset projects is complemented by critical perspectives on the credibility of the emissions reductions that they generate. In particular, the 'additionality' claims of offset projects – the measure by which emissions reductions are demonstrated and quantified – have been highly controversial. Multiple reviews of offsetting projects, again primarily in the CDM, have cast doubt on the credibility of emissions reductions because additionality claims have been found in many cases to be either unsupported by project documentation or worse, completely unsupportable (Haya, 2007; Michaelowa and Purohit, 2007; Paulsson, 2009; Schneider, 2009). The issue came to public prominence when a cable was released by Wikileaks from the US Consulate in Mumbai reporting on a meeting with Indian officials and companies where it was agreed that most CDM projects in India, which hosts the second highest number after China, were non-additional (Schiermeier, 2011). Ultimately, because emissions reductions are measured against a counterfactual scenario that never occurs, additionality can never be known. However, a more fundamental critique of additionality is put forward by Lohmann (2011a: 100), who argues that the emissions reductions claims of offset projects privilege the rationality of capitalist actors in ways that suppress the democratic alternatives needed to chart low carbon development pathways.

Reflecting on these themes in research on carbon offsetting, Bumpus and Liverman (2008: 148–9) propose:

> [A research] agenda [that] would include detailed empirical studies of carbon reductions in particular places and through different networks and value chains, and further theoretical work on the commodification of carbon, the spatial relations of emissions trading, and the role of non-nation-state actors.

This agenda has only been partly realised. Newell and Bumpus (2012) and Newell (2009, 2014b) demonstrate how political relationships at, and across, different scales of CDM governance shape local project outcomes and the evolution of global climate policy. The financial relationships that emerge from, and exert pressure over, offset projects have also been studied (Descheneau and Paterson, 2011; Knox-Hayes, 2009). This chapter focuses on the carbon commodity trading relationships between offset projects and polluting companies engendered by the institutional link between the Kyoto mechanisms and the EU ETS. By concentrating on the effects of the CDM and JI where the vast majority of CERs and ERUs are surrendered, it contributes to a broader perspective on the socio-ecological outcomes of carbon offsetting. As the organisation of emissions in the EU ETS depends on the commodification of carbon outside its boundaries, it is also necessary to examine this relationship to evaluate the instrument's contribution to action on climate change.

The first section gives an account of the political history of the CDM and JI as part of the Kyoto process, and through the negotiation of the Linking Directive in the EU, as a background to their development and an introduction to their design. The chapter then responds to Bumpus and Liverman's proposal for a focus on the spatial relations of emissions trading by drawing on Harvey's (2001b, 2006) work on the history and geography of capitalist crisis and its displacement to conceptualise the commodification of carbon in the Kyoto mechanisms as a 'spatio-temporal fix' for corporations and their polluting installations in the EU ETS. Thirdly, it responds to Bumpus and Liverman's call for detailed empirical studies of carbon commodity networks by constructing a case study of the trading relationships of German energy company E.ON, to illustrate the operation, and assess the implications of, the link between the EU ETS and the Kyoto mechanisms.

The Clean Development Mechanism and Joint Implementation

The "Kyoto surprise"

The CDM and JI are products of the United Nations international climate regime. Alongside emissions trading they represent two of out of three flexibility mechanisms that formed a crucial part of the 1997 Kyoto Protocol. The US was the strongest advocate for emissions reduction flexibility through market mechanisms from the signing of the UNFCCC in Rio de Janeiro in 1992 to the final agreement at Kyoto. A flexibility principle was included in the UNFCCC, developed by US negotiators but originally proposed by a Norwegian think tank, that contained provisions for developed countries to meet the non-binding aim of stabilising emissions at 1990 levels "individually or jointly" (Newell and Paterson, 2010: 78–9; UNFCCC, 1992: Article 4). Developing countries tended to oppose the idea on the basis that it would dilute the responsibility of developed countries to cut their own emissions and blur the line drawn by the UNFCCC that excluded developing countries from such responsibilities (Paterson, 1996: 66). This opposition meant that the first concrete manifestation of the idea in the 1995 Berlin Mandate was a pilot, voluntary scheme that allowed joint measures between countries but did not produce credits that would count towards the targets of developed countries (Grubb et al., 1999: 45). The scheme was named 'activities implemented jointly' to make it clear that it was the particular projects, not the commitments, that were jointly held between developed and developing countries (Matthews and Paterson, 2005: 66–7; Oberthür and Ott, 1999: 152).

In the year before the Kyoto conference, the US adopted a "binding but flexible" approach that made the adoption of concrete emissions reduction targets and timetables, which they had successfully opposed in the UNFCCC, conditional on the inclusion of market mechanisms (Grubb et al., 1999: 88; Newell, 2000: 15). The US was joined by other members of the 'JUSSCANNZ' group of negotiators, which included Japan, Switzerland, Canada, Australia, Norway and New Zealand, in this position. As flagged in the previous chapter, European negotiators, to the contrary, had been less enthusiastic about the use of such mechanisms and instead favoured stronger domestic measures. Within the EU there were differing positions, particularly between Northern and Southern European countries where the former tended to be more in favour of stronger measures. Such differences were, however, dealt with by the demand for an EU-wide cap that would allow the target to be distributed between EU countries (Newell, 2000: 14). European negotiators as a whole responded to the US position, following a decision of the Council of the European Union, by indicating a willingness to accept market mechanisms if they were "supplementary to domestic action" in the interests of reaching an agreement (Skjærseth and Wettestad, 2008: 67).

A similar movement in both of these directions was evident among industry groups, on the one hand, and NGOs, on the other. From its formation in 1989, the Global Climate Coalition was the most influential industry group opposing the adoption of emissions targets and policies. It represented oil, gas, electricity and carbon-intensive manufacturing companies, primarily based in the US but including European companies, and supported its case with a strategy that questioned climate science and emphasised the negative economic impacts of climate action (Levy and Egan, 2003: 819; Newell and Paterson, 1998: 683). This 'do nothing' position was opposed by environmental groups such as CAN International, a coalition of the major environmental NGOs originally from developed countries but subsequently expanding internationally, which was also formed in 1989 (Alcock, 2008: 81–2; Newell, 2000: 126–7). CAN International's position at Kyoto was for a binding emissions reduction target of 20 per cent below 1990 levels by 2005, to be made domestically and without the use of market mechanisms (Betsill, 2002: 53).

Actors from both of these groups emerged to form a coalition that supported the combination of binding emissions targets and market mechanisms. UK oil corporation BP formally split from the Global Climate Coalition in 1996 and US NGO Environmental Defence departed from the official position of CAN and worked with BP on market mechanisms (Meckling, 2011: 82–3). Charting a course that would later be replicated by business in the negotiations for the EU ETS, BP, joined by chemicals company Dupont and other companies represented by the International Climate Change Partnership, threw their support behind market mechanisms primarily as a defensive strategy against less favourable policies (Meckling, 2011: 84–5). Other industries that hoped to directly benefit from climate policy, such as clean technology industries, represented by the Business Council for Sustainable Energy, and the insurance industry, which was threatened by the prospect of large payouts for climate change-induced events, were also broadly in favour (Levy and Egan, 1998: 346; Newell and Paterson, 1998: 696).

China, and most other developing countries operating under the 'Group of 77' (G77) banner, maintained their opposition to North-South flexibility mechanisms in the lead up to the Kyoto negotiations, although with notable exceptions such as Costa Rica, which saw potential domestic benefits of forestry offset projects. During the Kyoto negotiations, a framework for JI, outlined in Article 6 of the Protocol although not actually named as such, was agreed to with relative ease by limiting projects and trading to within the developed countries listed in Annex I of the UNFCCC (Grubb et al., 1999: 89). This restriction somewhat circumvented developing country opposition because all countries involved would have emissions targets and therefore any credits produced for countries investing in projects would be deducted from the host country's emissions cap. Former Soviet bloc countries were heavily in favour of JI because, given the significant decrease in their emissions levels following the collapse of industrial production in the 1990s, they could afford deductions from their emissions cap and benefit from project investment and the sale of credits (Grubb et al., 1999: 97; Oberthür and Ott, 1999: 153–5).

Remarkably, a North-South flexibility mechanism in the form of the CDM did emerge, as briefly outlined in the Introduction to this thesis, out of a proposal by the Brazilian government for a 'clean development fund', which was to be financed by penalties for developed countries that breached their emissions targets. The proposal was strongly supported by the G77 but opposed by many developed countries that had, like the US, objected to what they viewed as rigid and punitive approaches (Grubb et al., 1999: 101–2; Oberthür and Ott, 1999: 166). The US, however, responded to the proposal proactively by arguing that it could be made consistent with the market logic by flipping its design. Rather than a redistributive fund, the US reframed the proposal as an investment mechanism, where the projects that Brazil envisaged would be supported by a "penalty for not complying" would instead be considered as "contributing to compliance" (Grubb et al., 1999: 103). With some compromises, such as adaptation funding provisions from CDM project revenues demanded by the Alliance of Small Island States (AOSIS) and provisos that the use of offset credits would be supplemental to domestic action, as urged by the European Community, broad support for the CDM, established in Article 12 of the Kyoto Protocol, was achieved. In a subsequent speech, the Chairman of the Kyoto Conference, Raúl Estrada Oyuela, reflecting on the CDM's role in securing an agreement and its unconventional evolution as a market mechanism, memorably described the CDM as the "Kyoto surprise" (Werksman, 1998: 147).

Developments following agreement at Kyoto were significant for the implementation of both Kyoto mechanisms. The text of the Protocol provided an overall framework for the CDM and JI, but many of the details, such as the project approval process, the eligibility of sectors such as forestry, and governance arrangements were decided and outlined in the Marrakech Accords of 2001 (Boyd and Schipper, 2002: 185–6). Paterson and Stripple (2012: 572–3) point out that the Marrakech Accords were the first time CERs and ERUs, the commodities of the CDM and JI, respectively, were reified as units of CO_2-e. Despite achieving the inclusion of flexibility mechanisms, 2001 was also the year that the President Bush formally withdrew the US from the Kyoto Protocol, in line with the pre-Kyoto demands of the US Senate not to accept an agreement that didn't also include developing country targets (Meckling, 2011: 134–5). The previous chapter noted that this was one of the international factors that contributed to the development of the EU ETS. The EU ETS, in turn became the driving force behind the growth of the Kyoto mechanisms, through the Linking Directive that established connections between the two schemes.

The Linking Directive

International linkages with the Kyoto mechanisms were major parts of the debate over the scope of, and allocation in, the EU ETS. The issue was largely excluded from the negotiations for the EU ETS Directive because at the time of the Commission's proposal for a European carbon trading system, the rules for the CDM and JI had yet to be finalised, and opposing views on the mechanisms, especially between industry and environmental groups, threatened to derail the rest of the EU ETS Directive (Skjærseth and Wettestad, 2008: 46). The clear intention of the EU ETS Directive was, nonetheless, to connect the schemes. It stated that "linking the project-based mechanisms, including Joint Implementation (JI) and the Clean Development Mechanism (CDM), with the

Community scheme is desirable and important" and foreshadowed the adoption of a parallel directive in this direction (European Parliament and Council, 2003: Article 30). This process was kicked off with a proposal for the Linking Directive from the Commission the day after the Council agreed to the EU ETS Directive in July 2003. The progression from proposal to adoption of the Linking Directive in 2004 was even faster than for the EU ETS Directive. Once again, within this overall direction towards adoption, contestation continued over similar issues that vexed debates over the EU ETS Directive, including the quantitative distribution of offsets and qualitative boundaries on eligible offset types.

Contestation over the quantitative distribution of offset credits focused on whether the Kyoto Protocol's supplementarily provision would translate to a cap on offset credit use and at which level – national state or EU – this would be decided. The Environment Directorate-General of the Commission initially favoured an EU-determined cap, but after opposition from the Enterprise Directorate-General, states and industry, only proposed a mechanism to trigger a review of the need for a cap of "for example 8%" once offset use reached 6 per cent of total allowance allocation (European Commission, 2003). The majority of member states, with the notable exception of Germany and the Netherlands, opposed caps in order to promote flexibility, reflecting the shift to a more positive view of market mechanisms. The Central and Eastern European states that were in the process of acceding to the EU also actively opposed caps because they wanted to host JI projects in their non-EU ETS sectors and sell ERUs to installations in Western European countries (Flåm, 2009: 28–9). Similarly, the Commission's proposals for qualitative limits on offsets from certain projects, including a ban on forestry and nuclear offsets and social and environmental safeguards on dam projects, were each opposed by various configurations of EU states (Skjærseth and Wettestad, 2008: 116–7).

The positions of polluting corporations and their industry groups outlined in the previous chapter translated to demands to maximise use of offset credits. In contrast, environmental groups took a different position on international linkages to their approach to the EU ETS as a whole. While willing to accept a tightly regulated EU ETS, they continued their Kyoto position on carbon offsetting by opposing the use of CERs and ERUs in the EU ETS. Indeed, one of CAN Europe's conditions for supporting an EU ETS was that "links to the project mechanisms should also not be made, as they will unnecessarily inflate the [carbon] budget and divert attention away from domestic reductions" (Climate Action Network Europe, 2002). Despite a position that opposed the Linking Directive, CAN Europe and many of their prominent member organisations, including Greenpeace and WWF, again adopted a 'quality control' approach as a secondary strategy, arguing for strict caps on offset use, limiting projects to renewable energy and extra social safeguards (Climate Action Network Europe, 2004).

Throughout the debate the most of the Parliament was in favour of imposing quantitative and qualitative restrictions but acquiesced on the issue of caps in return for more limited bans on certain project types (Skjærseth and Wettestad, 2008: 47). In the final Linking Directive prospects for an EU level cap gave way to a system where member states had control over determining allowable offset use for each installation, although their decisions would be overseen by the Commission for consistency with Kyoto supplementarity requirements as part of the national allocation plan process (European Parliament and Council, 2004: 20, 23). Forestry and nuclear offsets were banned until 2008 and 2013, respectively, although both bans have been extended in practice, and hydroelectric power projects over 20MW in size needed to adhere to the social and environmental guidelines set out by the World Commission on Dams (European Parliament and Council, 2004: 21).

Overall, agreement on the Linking Directive in the months before the start of the EU ETS delivered polluting capital access to the surrender of CERs and ERUs in lieu of EUAs from almost all project types, although further restrictions on CERs were introduced from 2013 that are considered in detail in Chapter Seven. Commission oversight did indeed result in a tightening of allowable offset use by installations in the many countries – some by up to half – that had their national allocation plans rejected for overgenerous offset caps (Flåm, 2009: 31). Nevertheless, polluters also secured access to a significant quantity of offsets, later capped at 50 per cent of total EU ETS emissions reduction efforts between 2008 and 2020 (European Parliament and Council, 2014: Article 11a). Post-2012 eligibility of ERUs in the EU ETS has since been disrupted, however, by the absence of an agreement on the successor to the Kyoto Protocol at UN negotiations (European Commission, 2015a). Before analysing the use of CERs and ERUs in the EU ETS overall and through a case study of E.ON, the next section conceptualises the spatial and temporal dynamics of the Kyoto mechanisms by bringing in Harvey's insights on the history and geography of capitalist crisis.

The spatio-temporal fix

Capitalist crisis and displacement

According to Marxist political economy, crises of capitalism inevitably develop out of contradictions within and between the production and realisation of surplus value in the circuit of capital. Competitive pressures and class relations demand constant improvements in labour productivity through technological and institutional changes that are necessary to maintain profitability but lead to the overaccumulation of capital (Harvey, 2001b: 313–6). Particular forms of fixed capital, workforces, state regulation and infrastructure support "certain kinds of production, certain kinds of labour processes, distributional arrangements [and] consumption patterns" that eventually become barriers to the profitable reinvestment of surplus value needed to sustain capital accumulation (Harvey, 2006: 428). All else being equal, the ensuing crisis can only be resolved through a wholesale devaluation of capital.

However, Harvey (2006: 425) stresses that all else is not equal and accordingly seeks to "integrate the geography of uneven development into the theory of crisis." The perennial restructuring of the organisation of capitalist production contributes to uneven development. Harvey conceptualises this dynamic in terms of the contradiction between 'fixity' and 'motion' in the circulation of capital (see also Brenner, 1998). Paradoxically, "spatial organization is necessary to overcome space" because the circulation of capital as 'value in motion' depends on social and physical infrastructures that are relatively immobile (Harvey, 2001b: 328). These organisational arrangements see certain individual capitals, sectors and regions develop at the expense of others.

Harvey (2006: 424) considers how this "framework of uneven geographical development, produced by differential mobilities of various kinds of capital and labour power," both contributes to endemic crises of capital accumulation, and contains possibilities for crisis displacement. Capital, Harvey argues, can make use of uneven spatial configurations by 'switching' to underdeveloped capitals, sectors and regions with greater capacity to absorb surpluses and therefore sustain capital accumulation for a time. Such moves are coordinated by a range of "nested hierarchical structures of organisation" including institutions such as states, corporations and money that link – and produce – various local, regional, national and international scales (Harvey, 2006: 422). For example, credit markets and state policies may coordinate the movement of capital towards, and create opportunities for, more profitable endeavours. While this is not a costless exercise, "the geography of uneven development helps convert the crisis tendencies of capitalism into compensating regional configurations of rapid accumulation and devaluation" (Harvey, 2006: 428).

The limits of this strategy of crisis displacement are also explored by Harvey who develops Hegel's dialectic of inner and outer transformations aimed at resolving the internal contradictions of civil society. While conditions of uneven development within a particular region provide possibilities for crisis displacement, "options for the internal transformation of capitalism become increasingly limited" by those very conditions (Harvey, 2001b: 328). For example, the centralisation of capital both increases the extent of uneven development, and therefore the advantages of switching, while also limiting opportunities to do so because it reduces the domain of the market needed make the switch (Harvey, 2006: 141). Such limits to internal transformations see the inertia of existing fixed social and physical infrastructures, and with it the threat of devaluation, resurface (Harvey, 2001b: 300). However, Harvey (2006: 427) also argues that the exploitation of uneven development is not limited to within a given territory, and that the threat of devaluation "is, of course, exactly the kind of 'inner dialectic' that forces society to seek relief through some sort of 'spatial fix'."

Harvey's framework is useful for reconceptualising the socio-ecological relations that underpin but limit carbon allowance trading, which necessitates a spatial (and temporal) fix from the Kyoto mechanisms. First, there are clear parallels between Harvey's argument on the possibilities for switching between unevenly developed capitals, sectors and regions and the possibilities for polluting corporations to exploit the uneven organisation of emissions by substituting between different forms of carbon appropriation. Here, the institutional processes that commodify carbon function as nested hierarchical structures by connecting particular installation-emissions relationships with each other through the general measure of the carbon allowance. It is in linking the particular with the general that the carbon commodity most clearly functions like money, something that is largely overlooked by Descheneau's (2012) study of carbon as money. Second, just as the uneven development of capital creates limits for internal restructuring, the uneven appropriation of carbon by a small proportion of privately and state-owned corporations and their large-scale installations limits the scope for sourcing carbon allowances elsewhere from other actors. This matters because the preservation and expansion of value embedded in, and created by, carbon-intensive production processes regulated by the EU ETS depends on access to carbon allowances, or their carbon offset equivalents.

Carbon offsetting as spatial fix

Outer transformations that Harvey terms 'spatial fixes' are vital for restoring conditions for capital accumulation in the face of limits to inner transformations. Spatial fixes use "geographical expansion, spatial reorganization and uneven geographical development" to find profitable outlets for surplus capital in external regions in order to defer the devaluation of capital in internal regions threatened by crises of overaccumulation (Harvey, 1995: 2). Geographical expansion through the spatial fix has been critical for the survival of capitalism and depends on many of the same nested hierarchical structures, such as states, the finance system and corporations, that facilitate internal reorganization. The exact form of spatial fix depends on whether and how the crisis of overaccumulation manifests as too many commodities relative to demand, idle production capacity or shortages in labour power and natural conditions (Harvey, 2001a: 25–6). Thus, spatial fixes range from opening up new markets for consumer goods to the export of productive capital and securing access to new workers or raw materials, whether through economic contract, political agreement or military force (Harvey, 2001b: 335–8, 2006: 432–8). Harvey (2003a: 141) stresses that while capitalism requires an 'outside' to achieve spatial fixes, it "can make use of some pre-existing outside" or, more regularly, "it can actively manufacture it." Boundaries are therefore necessarily fixed but constantly recreated (Harvey, 2006: 427). This resonates with Smith's (2008: 116) contention that "where absolute space occurs in geographic terms today, it is the product of human activity; the absoluteness of such spaces is a social product, not a feature of natural space."

The Kyoto offsetting mechanisms can be understood as a spatial fix by considering both meanings of 'fix' identified by Harvey. The first is the metaphorical meaning of 'a fix' as a temporary resolution and the second is the material idea of spatial 'fixity' (Harvey, 2003b: 65–6). In the metaphorical sense, the CDM and JI provide a spatial 'fix' for companies or governments that would otherwise need to reduce emissions within the EU ETS or domestically. When the CDM and JI were first agreed to, the fix was directed at all states with emissions reduction targets under the Annex B of the Kyoto Protocol. While governments of and companies in Japan and Switzerland have also surrendered CERs and ERUs, in practice the fix has mostly benefited companies that own installations in the EU ETS, which are estimated to have accounted for around three-quarters of global demand for the credits (Stephan et al., 2014: 9–10; World Bank, 2012: 71).

Of the just over 2 billion offset credits issued to CDM and JI projects by 1 May 2013, the day after the final phase two compliance date, 52 per cent had already been surrendered by installations in the EU ETS (European Commission, 2013b; Fenhann, 2014a, 2014b). These 1.059 billion surrendered CERs and ERUs allowed EU ETS installations to release 1,059Mt CO_2-e more greenhouse gas emissions than the total emissions cap between 2008 and 2012. Mostly due to the combined effects of the economic crisis and the over-allocation of allowances, total phase two emissions were 702Mt CO_2-e below free allocation levels (European Environment Agency, 2013a). Therefore, the main uses of CERs and ERUs in phase two were to reduce the costs of complying with EU ETS because of the lower price of CERs and ERUs, and to provide a fix to companies' post-2012 emissions caps by supporting the enhanced banking of EUAs.

The spatial 'fix' is dependent on the 'fixing' of global difference into internal and external spaces in order to restructure the geographical management of greenhouse gas emissions and carbon sinks. The difference the CDM builds upon is the general socio-spatial divide between developed and developing countries that characterised early UN climate conferences and was codified as Annex I and non-Annex I countries to the UNFCCC. The instrument creates an external space in the South where representations of the appropriation of carbon are produced and an internal space in the North where those commodities are consumed. Paradoxically for the US, which withdrew from Kyoto because developing countries were not subject to emissions caps after heavily pushing for the CDM, the spatial fix is underpinned by differentiated emissions targets between developed and developing countries. It is this regulatory unevenness that allows the operators of projects in any non-Annex I country that has ratified the Kyoto Protocol to be credited for their emissions reductions. As with spatial fixes to crises of overaccumulation that seek relief from external territories in addressing internal constraints, the CDM allows polluters to draw on commodified representations of project-emission reduction relationships that are external to the EU ETS to maintain their emissions within the boundaries of the scheme.

As mentioned above, unlike with the CDM, both host and investor countries participating in JI projects have Kyoto targets and therefore the emissions value of carbon credits sourced by the buyers are deducted from the Kyoto target of the seller. The institution of the EU ETS and its links with the Kyoto mechanism created a new set of boundaries internal to Annex I countries between the forms of carbon appropriation that are, and are not, represented within the EUA. The Linking Directive produced this boundary in stating that "no ERUs or CERs are issued for reductions or limitations of greenhouse gas emissions from installations falling within the scope of [the EU ETS] Directive" (European Parliament and Council, 2004: 21). Despite the institutional structure of the JI remaining unchanged, the dominance of the EU ETS in shaping demand for ERUs effectively redefined the scope of JI to include Annex I countries not covered by the EU ETS, as well as projects involving greenhouse gases, production processes or pollution scales within countries covered by the EU ETS but outside the scope of the EUA.

Spatial fixity in the CDM and JI goes all the way down to the local level where projects are fixed in particular places. The spatial fix expands the scope of abstraction within carbon commodities to the greenhouse gases, production processes, and geographical locations that constitute offset projects in those places. Each type of abstraction is much broader than the EU ETS. JI and CDM projects can reduce any of the six types of greenhouse gases, including methane and hydrofluorocarbons, be involved in a range of production processes in the transport, agricultural, extractive and waste sectors and be located in any country that has ratified the Kyoto Protocol (UNFCCC, 1997: Annex A). By commodifying relationships between projects and emissions reductions involving these factors, CDM and JI significantly increase levels of differentiation that can be exploited by polluters in the EU ETS. This occurs through quite different commodification processes compared to those involved in carbon allowances, by commodifying representations of decreases in emissions over time.

Carbon offsetting as temporal fix

In contrast to the commodification of relationships between installations and actual emissions, detailed critical analyses have shown that carbon offsetting instruments commodify relationships between projects and emissions that do not materialise. Knox-Hayes (2013: 117), for example, says "carbon credits are artificial commodities in the sense that they are constructed from the *absence* of emissions, rather than the existence of something" (emphasis added). Similarly, Bumpus (2011: 620) states that the carbon commodity, "given its *non-existential* nature, could be termed a piece of 'counterfactual material nature'" (emphasis added). Understanding the object of commodification in counterfactual terms follows the method used to define and calculate the 'emission reduction' side of the offset relationship. What matters is not that emissions are reduced by a project absolutely, but that emissions levels are relatively lower than they would have otherwise been.

The central question is that of 'additionality', which seeks to compare emissions released with and without the project. The 2001 Marrakech Accords defined emissions reductions from CDM projects as additional "if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.'' An almost verbatim definition of additionality was also adopted for JI (UNFCCC, 2001: 61, 83). Additionality is established using a range of related tools. In the CDM, these include 'barrier analysis', which identifies financial, technological, policy or other barriers to the project, 'investment analysis', which compares the profitability of different scenarios and 'common practice analysis', which considers whether a project goes beyond industry norms in the host region (Schneider, 2009: 243–50). A baseline emissions scenario is then constructed using these tools that takes account of a combination of historical emissions levels with existing barriers, the most profitable path available for the project developer and/or common technological practices in relevant parts of the economy (Paulsson, 2009: 68). Emissions reductions are calculated out of the difference between the baseline scenario and actual emissions.

The primary difference between the commodification processes in the CDM and JI is institutional rather than logical. JI host countries that meet certain carbon accounting guidelines are able to verify emissions reductions of projects they host independently. JI projects in countries that don't meet the carbon accounting guidelines or choose to use the external procedure are overseen by the JI Supervisory Committee. All CDM projects are overseen by the CDM Executive Board. Both the JI Supervisory Committee and the CDM Executive Board sit under the UNFCCC and are comprised of representatives of relevant member states. Projects are registered by each institution after processes of validation (CDM) or determination (JI) by private contractors known as 'designated operational entities' (CDM) and 'accredited independent entities' (JI) that review their additionality. CERs and ERUs are then issued after a different designated operational entity or accredited independent entity verifies the emissions reductions that have been monitored by the project have indeed taken place (Schmitz and Michaelowa, 2005; Yamin, 2005).

The performance of additionality, which is needed to commodify relationships between projects and emissions reductions that are not regulated by the EU ETS, follows the dynamics of Harvey's 'temporal fix'. While Harvey doesn't always use the term, it is a key component of his theoretical work on the history and geography of capitalist crisis and its displacement (Jessop, 2006: 149). The temporal fix primarily refers to the role of the financial system in deferring crises of overaccumulation through the creation of what Marx termed 'fictitious capital'. Fictitious capital is a form of capital if the credit or other financial product is extended to support expanded accumulation. It is fictitious because the capital being advanced has not yet materialised as value, but rather, is a tradeable "claim exercised by money capital over a share of future surplus value production" (Harvey, 2006: 267). Fictitious capital provides a temporal 'fix' in the metaphorical sense to crises of overaccumulation by switching from present to future surplus value production and realisation. For example, the fix may absorb existing surpluses of money by financing investment in fixed capital with a long turnover time, or bring forward the purchase of surplus commodities with consumer credit (Harvey, 1991: 182–3). In both cases, the "faith and expectation" is that the fictitious capital will ultimately become real with future accumulation (Harvey, 2006: xxvi).

Similarly, the commodification of carbon in the Kyoto mechanisms rests on expectations of future emissions, and faith in the methods used to calculate baselines. As with fictitious capital, greater expectations for future growth in emissions over a period translate to the issuance of more carbon credits. The temporal fix goes well beyond the more limited temporal abstraction of carbon allowances discussed in the previous chapter, especially for CDM projects, which have a total crediting period of 7-14 years. Büscher (2012) touches on related themes when describing various efforts to commodify conserved nature as "fictitious conservation." The term builds on the notion of fictitious capital because, as with carbon offsetting, conservation is defined by the absence of something, such as the non-development of land for housing or industry. What Büscher's formulation misses, though, is the temporal dimension to such determinations, which is the critical element for both the conversion of fictitious into real capital, and the conversion of emissions reductions into actual emissions. In this sense, Paterson's (2014: 577) analogy of the differences in commodification in cap and trade vis-à-vis baseline and credit schemes as resembling the difference between "fiat" (i.e. state-backed) and "debt" (i.e. promise to pay) money is more apt.

The inner relationship between the spatial and temporal axes of crisis displacement and deferral is recognised by Harvey (2003b: 64) in the conceptualisation of the "spatio-temporal fix." The coupling of the spatial and temporal aspects of the CDM and JI is critical to the fix for carbon-intensive companies in the EU ETS. As spatial fix, the CDM and JI expand the different forms of carbon appropriation covered by carbon markets. As temporal fix, the CDM and JI represent relationships between projects and emission reductions in these external spaces in commodity form. The equalisation and exploitation of increased levels of difference between the internal and external spaces through the trading of carbon credits from offset projects to EU ETS installations is analysed and illustrated in the final section of this part of the thesis.

Trading carbon credits

E.ON's offset strategy

This section follows the method employed in the previous chapter in focusing on the ultimate owner that surrendered the greatest number of carbon credits between 2008 and 2012: E.ON. As outlined in Chapter Three, E.ON is, along with RWE, one of Germany's two main energy utilities, and the EU ETS's second largest polluter.

Table 5.1 shows the ten ultimate owners that surrendered the highest quantity of offsets in phase two in absolute terms, with E.ON at the top, surrendering 53Mt CO_2-e worth of CERs and ERUs. All ten, except ThyssenKrupp, which is the 25th largest, are top 20 EU ETS polluters. The table also reports the relative use of offsets as a percentage of phase two surpluses or deficits. This shows offsets allowed many large polluting companies to increase their emissions well above their allowance allocation levels. E.ON's offsets covered 70 per cent of its allowance allocation deficit, which placed it in the middle of the eight ultimate owners on the list that had an overall phase two deficit in terms of reliance on offsets. Allowance use ranged from 11 and 12 per cent of phase two allocation deficits for RWE and the Swedish Government (mostly Vattenfall), to 151 and 152 per cent for German energy consortium KSBG and the Government of Poland (mostly PGE), respectively. These figures of greater than 100 per cent for KSBG, the Polish government, as well as Enel, indicate that installations owned by these companies surrendered offsets in excess of their allocation deficit. There are also two ultimate owners in the top ten offset users, steel producers ArcelorMittal and ThyssenKrupp, which had an overall allowance surplus.[7] All or some of the CERs and

[7] Steel companies such as ThyssenKrupp and ArcelorMittal argue that their allowance surpluses are inflated due to waste gas transfers to power companies, such as those highlighted to RWE in the previous

ERUs surrendered by KSBG, the Polish government, Enel, ArcelorMittal and ThyssenKrupp therefore had the additional purpose, beyond compliance, of freeing up allocated allowances to bank for future use or sell for profit.

Table 5.1: Top ten EU ETS offset users 2008-12

Ultimate owner	**CERs (Mt CO_2-e)**	**ERUs (Mt CO_2-e)**	**Total offsets surrendered (Mt CO_2-e)**	**Phase 2 surplus/deficit (Mt CO_2-e)**	**Offsets as percentage of (surplus)/deficit**
E.ON SE	41	12	53	-76	70%
Enel SpA	45	1	46	-39	116%
ArcelorMittal SA	33	12	45	155	(29%)
Government of Poland	35	4	39	-26	151%
RWE AG	12	13	25	-223	11%
GDF Suez	18	6	24	-47	51%
Government of Greece	10	10	20	-21	94%
ThyssenKrupp AG	6	13	20	33	(59%)
Government of Sweden	17	2	19	-156	12%
KSBG GmbH & Co KG	10	7	17	-11	152%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2013b, 2014d, 2014i, 2014l, 2014n).

The available trading data shows that, as with RWE, accounts linked with E.ON installations purchased the majority (59%) of their allowances and credits from other E.ON accounts. Most offsets were surrendered by E.ON installations through this route via trading accounts controlled by the company's speciality trading desk, E.ON Global Commodities (European Commission, 2014i). E.ON Global Commodities trades carbon alongside other commodities and derivatives including electricity, gas, oil, coal and weather (E.ON, 2014a). It claims to have traded a total of 721Mt of carbon in 2012, about equal to E.ON's total phase one and two emissions (E.ON, 2014b).

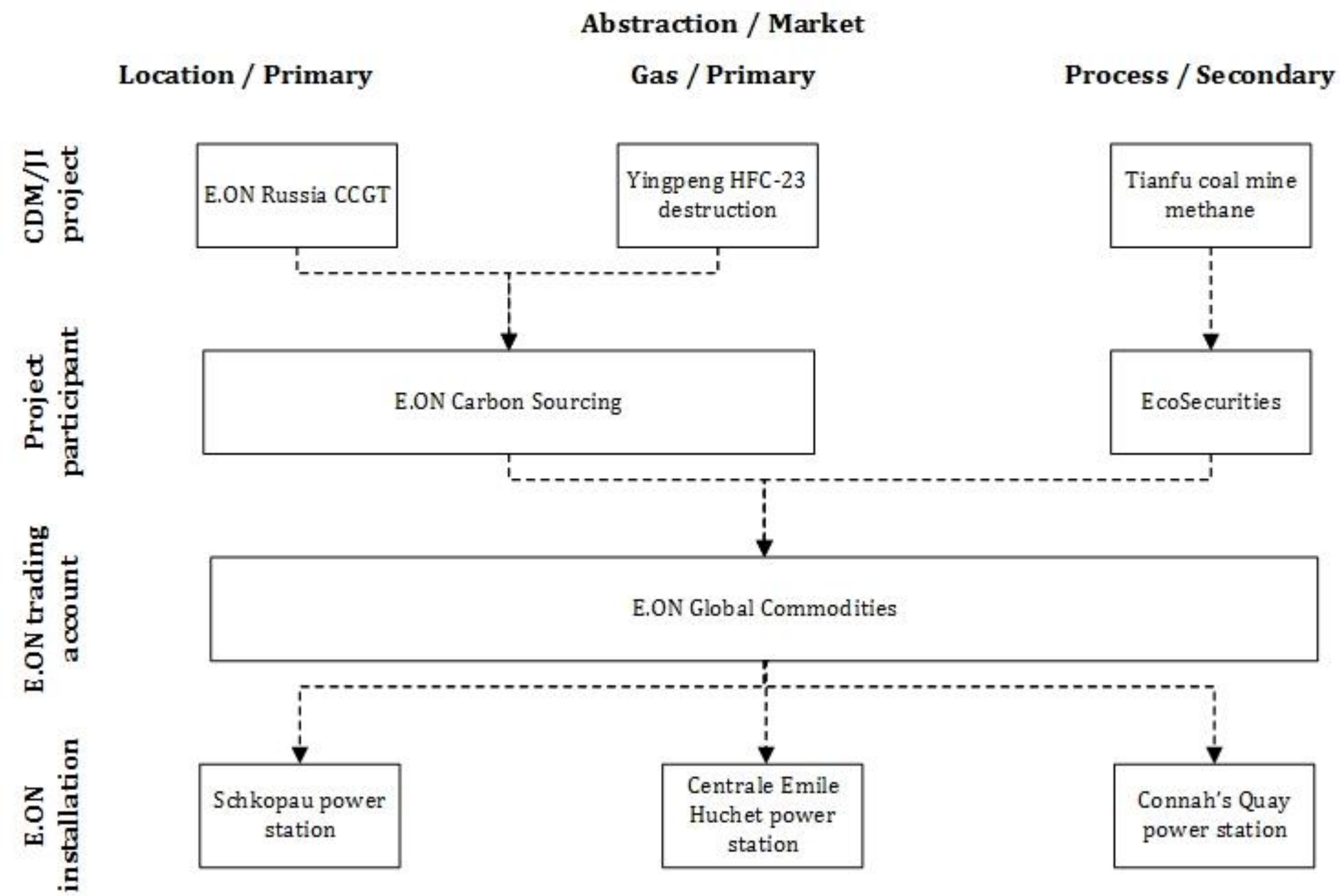
The sourcing of offsets is commonly broken down in two broad ways. The first way is the 'primary' offset market where carbon credits are sourced from direct participation in offset projects. The second way is the 'secondary' offset market where credits are

chapter (Elsworth et al., 2011). It is not possible to accurately adjust their surpluses downward because comprehensive data on waste gas transfers is not publicly available.

purchased in over-the-counter or exchange-mediated contracts from third parties. E.ON Carbon Sourcing, a subsidiary of E.ON Global Commodities, describes the former as its "make" strategy, where the price of offsets is determined by the cost of production, and the latter as its "buy" strategy, where the price is determined by the market (Russo and Odeska, 2009). The primary offset market can be further split up into different levels of participation, which can involve direct investment in the project or an 'emissions reduction purchase agreement' with the project developer to simply purchase offsets directly.

E.ON subsidiaries, including E.ON Carbon Sourcing, are named as 'project participants' in 24 registered CDM and three registered JI projects (Fenhann, 2014a, 2014b; UNFCCC, 2014a, 2014b). Offset commodity flows from these projects to installations can be much more precisely studied than with carbon allowances because the European Commission (2013b) publishes a complete list of the CDM and JI project IDs of carbon credits surrendered by EU ETS installations. Between 2008 and 2012, installations owned by E.ON ultimately surrendered CERs and ERUs produced by 12 of the CDM and one of the JI projects that they directly participated in. In total, E.ON installations surrendered 17,033,277 carbon credits from this primary market route, which represented 32 per cent of all offsets surrendered by the company (European Commission, 2013b). Trading data shows that the trading accounts of the E.ON subsidiaries that acted as project participants, such as E.ON Carbon Sourcing, sold all their credits internally to E.ON Global Commodities, which in turn traded with E.ON installation accounts and third parties (European Commission, 2014i). The other two-thirds of credits surrendered by E.ON were therefore bought in the secondary market. The following case study of E.ON's offset trading is organised similarly to the RWE case study. It includes examples of the two kinds of primary market trading, and as well one example of a secondary market trade. Each example illustrates how the Kyoto mechanisms expand a different type of abstraction – scalar, functional and processual – to provide a fix to the limits of commodification in the EU ETS. Figure 5.1 represents the CER/ERU commodity flows in the three examples between various actors from the offset project that produced the credits to the EU ETS installation that finally surrendered the credits, in terms of the two axes of market segment and forms of abstraction highlighted.

Figure 5.1: E.ON CER/ERU commodity flows



E.ON's offset trading

Linking the EU ETS to the CDM and JI provided polluters in Europe with a fix by expanding the scope of spatial abstraction beyond countries within the EU to less wealthy countries in the Global South and the former Soviet Union. For E.ON, this geographical expansion beyond the scope of the EU ETS didn't necessarily require trading relationships that went beyond the boundaries of the corporation because those boundaries also expand beyond the EU. Indeed, one of E.ON Carbon Sourcing's JI projects, the Shaturskaya power plant in Shatura, Russia, is owned by E.ON Russia Power.

The project involved the construction of a new 400MW combined cycle gas turbine power plant. It claims additionality on the basis that without the project, electricity would be produced by other corporate actors from more polluting alternatives, such as coal-fired power (Global Carbon, 2010: 3). This project-emission reduction relationship is commodified not because it replaces power from existing coal-fired stations, but because it replaces coal-fired power that would otherwise be needed to meet projected future increases in energy demand. This illustrates the capitalist teleology that underpins the formation of baselines, as possibilities, such as demand reduction, that could also avoid the need for more coal-fired power stations, are not considered in any of the alternative scenarios in the project design document (Global Carbon, 2010: 13–14). In assuming the need for new generation capacity, the choice of a combined cycle gas turbine is asserted as additional due to geographical differentiation in technology standards, as "most of the new gas power plants in North America and Europe are of this type, whereas in Russia this is not the case" (Global Carbon, 2010: 8).

The fix specifically benefited two E.ON installations that surrendered 416,887 ERUs from the project between 2008 and 2012: the 900MW brown coal-fired Schkopau power plant in Saxony-Anhalt, Germany and the 1,000MW black coal-fired Ironbridge power station in Shropshire, the UK (E.ON, 2015c, 2015e; European Commission, 2013b). This contributed to closing the phase two gap between allocation and emissions of 10,716,207t CO_2-e for the former and increasing the latter's 1,655,724t CO_2-e phase two surplus. Two large installations not owned by E.ON, ThyssenKrupp's Duisburg steelworks in Germany and Riva Fire's Taranto steelworks in Italy, both also surrendered ERUs from the E.ON project despite both recording healthy allowance surpluses, illustrating the economic significance of the spatio-temporal fix for E.ON beyond its own compliance requirements.

Table 5.2: Origin of offsets surrendered by E.ON installations 2008-12

Country	**Mechanism**	**CERs/ERUs (Kt CO_2-e)**	**Percentage of offsets**
China	CDM	27,668	52%
Ukraine	JI	8,406	16%
South Korea	CDM	7,111	13%
India	CDM	5,047	9%
Russia	JI	3,437	6%
Brazil	CDM	1,020	2%
Mexico	CDM	214	0.4%
Vietnam	CDM	154	0.3%
South Africa	CDM	117	0.2%
Argentina	CDM	106	0.2%
Malaysia	CDM	44	0.1%
Thailand	CDM	21	0.04%
Lithuania	JI	18	0.03%
France	JI	7	0.01%
Pakistan	CDM	4	0.01%
Estonia	JI	3	0.005%
Egypt	CDM	2	0.003%
Israel	CDM	1	0.002%
Peru	CDM	1	0.002%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2013b, 2014d, 2014i, 2014l, 2014n).

Table 5.2 shows that Russia and the Ukraine hosted the JI projects that were issued the great majority of ERUs surrendered by E.ON's installations. These two countries have dominated the JI market, representing 90 per cent of all issued ERUs and 99.8 per cent of ERUs surrendered by E.ON installations (European Commission, 2013b; Fenhann, 2014b). The ERUs sourced from projects in Lithuania, France and Estonia that are outside the mandatory scope of the EU ETS in phase two demonstrates the operation of the spatial fix within the EU. For example, 7,175 ERUs produced by a nitrous oxide destruction project at an adipic acid production plant operated by chemicals companies Rhodia, and then Solvay, in Chalampé in the Alsace region of France, were surrendered by E.ON's Dąbska power plant in Szczecin, Poland (Rhodia Energy Services, 2008; SEC, 2015; Solvay, 2015). But the 22 per cent of offsets E.ON sourced from JI projects is outweighed by CERs sourced from CDM projects. For the EU ETS as a whole, 64 per cent of offsets surrendered were CERs and for E.ON it was 78 per cent (European Commission, 2013b).

The position of China at the top of Table 5.2 is primarily due to the 11 HFC-23 destruction CDM projects based in China that produced 41 per cent of the offsets surrendered by E.ON installations. Indeed, CERs from the destruction of HFC-23 have dominated the CDM market as a whole, with 22 HFC-23 destruction projects out of a total of 7,554 registered projects producing 35 per cent of all CERs by September 2014 (Fenhann, 2014a). These CERs were made possible by the CDM expanding the scope of functional abstraction beyond the gases covered by the EU ETS to HFC-23, which is covered by the Kyoto Protocol as a type of hydrofluorocarbon. Expanding to HFC-23 also expanded the scope of global warming potentials underpinning the carbon commodities circulating in the first two phases of the EU ETS from 298 for nitrous oxide to 11,700 for HFC-23 (UNFCCC, 1995).

The largest single supplier of CERs surrendered by E.ON installations, representing 24 per cent of the total surrendered, was the Yingpeng HFC-23 destruction project in Yongkang City, Zhejiang Province, China (European Commission, 2013b). E.ON also sourced these credits on the primary market as a formal project participant through E.ON Carbon Sourcing. Unlike the Russian JI project, this participation was limited to a contractual arrangement to directly purchase CERs, rather than a direct investment and operational role, as E.ON was only added as a project participant on 18 January 2010, after the registration and the beginning of the crediting period on 20 April 2009. It subsequently withdrew on 13 March 2013 following the ban on HFC-23 credits in the EU ETS, discussed in Chapter Seven (UNFCCC, 2014c).

The Yingpeng project reduces greenhouse gas emissions by collecting and decomposing HFC-23 – a by-product of the production of HCFC-22, which is used as a refrigerant gas

– into the less potent carbon dioxide and other chemicals (Climate Experts, 2009: 2). The commodification of this project-emissions reduction relationship firstly depends on differentiation in the regulation of HCFC-22 and HFC-23 in China. China does not have emissions reductions requirements for HFC-23 under the Kyoto Protocol. Under the Montreal Protocol, it also doesn't need to phase out HCFC emissions until 2030, which is a slower timetable than developed countries (UNEP, 2014). The differentiated treatment of China in these agreements is due to the recognition of its lower historical responsibility for ozone depletion and global warming compared to wealthy countries. It also allows the project to establish additionality by arguing that "as a developing country, there are no regulations which require the destruction of the total amount of HFC23 waste in China at this moment or in the near future" (Climate Experts, 2009: 9). Second, in addition to the regulatory space to continue producing HCFC-22 and to not destroy HFC-23, which is rooted in China's historical underdevelopment, the country's rapid development in recent years supports a baseline scenario with high levels of HFC-23 emissions to reduce. As a result of quickly increasing demand, HCFC-22 production capacity at the Yingpeng increased from 500 tonnes per year before 1997 to 25,000 tonnes per year in 2001 (Climate Experts, 2009: 3). As per the standard HFC-23 methodology, the baseline scenario is based on ongoing HCFC-22 production at its maximum 2004 level of 23,269 tonnes (Climate Experts, 2009: 11)

The spatio-temporal fix for E.ON installations is underpinned by the difference between the global warming potentials of carbon dioxide and HFC-23. 60 installations owned by E.ON in the Czech Republic, Germany, Spain, France, the UK, Hungary, Italy and Sweden ultimately surrendered 12,798,919 CERs from the project in phase two. Each E.ON installation is only regulated for carbon dioxide emissions. The E.ON installation that surrendered the most was the 1,873MW coal and gas-fired Emile Huchet power station in Saint-Avold, Lorraine, France, which surrendered 2 million Yingpeng CERs (E.ON, 2011; European Commission, 2013b). The difference in global warming potentials means that the destruction of 171 tonnes of HFC-23 at Yingpeng substituted for the reduction of 2 million tonnes of carbon dioxide by E.ON's Emile Huchet power station.

Table 5.3: Project type of offsets surrendered by E.ON installations 2008-12

Project type	CERs/ERUs (Kt CO_2-e)	Percentage of offsets
HFCs	29,709	56%
N_2O	10,791	20%
Fugitive	5,083	10%
Energy efficiency industry	3,471	7%
Coal bed/mine methane	1,162	2%
Hydro	804	2%
Fossil fuel switch	727	1%
Landfill gas	409	1%
Methane avoidance	278	1%
Energy distribution	200	0.4%
Energy efficiency own generation	185	0.3%
PFCs and SF6	167	0.3%
Wind	122	0.2%
Biomass energy	117	0.2%
Energy efficiency service	69	0.1%
Energy efficiency supply side	49	0.1%
Cement	30	0.1%
Landfill gas	6	0.01%

Sources: Own calculation using Bureau van Dijk (2014), Fenhann (2014a, 2014b) and European Commission (2013b, 2014d, 2014i, 2014l, 2014n).

Lastly, the range of project types which E.ON sourced carbon offsets from in Table 5.3 highlights the expansion of processual abstraction to aspects of production not commodified in the EU ETS but covered by the Kyoto Protocol. For example, fugitive emissions from coal mining processes, which supplied the fifth highest quantity of offsets to E.ON, are outside the boundaries of installation-emissions relationships commodified in the EU ETS. The largest supplier of surrendered CERs from coal bed methane projects to E.ON installations was the Tianfu project in the Beibei region of Chongqing, China. E.ON has never been a project participant and therefore acquired the CERs on the secondary market. The only project participant, other than the company that owns the mine, was Ecosecurities, which has participated in 307 CDM projects, making it the second most active project participant in the history of the CDM (Fenhann, 2014a). Ecosecurities was a specialist carbon market firm that was bought by investment bank JP Morgan Chase in 2009 and then subsumed into commodities trading company Mercuria in 2013 (Point Carbon, 2013).

The Tianfu project produces carbon credits by capturing coal mine methane and using it primarily to generate electricity for its own operations. Additionality comes from avoiding the venting of methane and replacing more carbon-intensive electricity from coal-fired power stations that would otherwise supply the local network (EcoSecurities, 2011: 2–3). One installation owned by E.ON, the 1420MW Connah's Quay combined cycle gas turbine power station in Flintshire, Wales, surrendered CERs from the project (E.ON, 2013a). Surrendering 304,309 CERs produced by the Tianfu project between 2008 and 2012 partly made up the installation's phase two deficit of 2,628,829t CO_2-e (European Commission, 2013b).

The trading relationship between E.ON and the Tianfu project illustrates why expanding the scope of processual – and, indeed functional (to methane) and spatial (to China) – abstraction through the Kyoto mechanisms militates against the efficacy of the EU ETS. Not only did the CERs produced by Tianfu allow E.ON to avoid reducing emissions at Connah's Quay; CDM status actually supported the appropriation of carbon at the project. Abstracted from the production process creating the emissions, it is better for the climate to burn methane for electricity rather than vent it. But when the source of the methane is taken into account it is clear that revenues from the sale of CERs at the project support fossil fuel-intensive accumulation in China. This is because the emissions reductions depend on ongoing – and expanding, according to project documentation – coal mining (EcoSecurities, 2011: 3).

Conclusion

Two related conclusions emerge from this chapter's consideration of the relationship between the EU ETS and the Kyoto mechanisms that build on the overall analysis of the commodification of carbon in this part of the thesis. First, the link with the Kyoto mechanisms further impedes the efficacy of the EU ETS by providing an external fix that offers additional means to sustain existing patterns of carbon appropriation beyond what is possible through carbon allowance trading alone. Second, by expanding levels of abstraction between differentiated forms of carbon appropriation that are equalised in carbon commodities, the substitutions involved in the trading and surrendering of offset credits are even less likely to represent effective forms of climate action.

In relation to the first conclusion, E.ON's heavy use of offsets to cover carbon pollution above its levels of free allocation has supported the maintenance of a European energy mix only marginally better than RWE's. Excluding E.ON's hydropower assets, which were mostly built in the early to mid-twentieth century, only 6 per cent of E.ON's electricity was produced by renewables in 2013 (E.ON, 2015a, 2015d: 36–7, 40, 43, 47). The poor climate performances of RWE and E.ON are significant in their own right because together they represent about one-eighth of both 2005-12 EU ETS emissions and 2013 EU electricity generation (RWE, 2014a: 17). Further, the experience of RWE and E.ON has been shared by the other large polluting companies in the EU ETS. In 2012, after two phases of the EU ETS, the ten largest electricity companies in the EU by generation output – all of which, except EnBW, are also in the top 20 EU ETS polluters – were responsible for over half of total electricity production, but only 4 per cent of this was from renewables (Dallos, 2014: 18). The Commission has calculated that to meet the EU's own goal of an 80-95 per cent reduction in greenhouse gas emissions from 1990 levels by 2050, renewable energy needs to increase to between 64 and 97 per cent of electricity consumption, depending levels of energy demand management (European Commission, 2011a: 6–7). As a climate policy that allows companies responsible for large shares of emissions to avoid investment in renewables, the EU ETS, including its links with the Kyoto mechanisms, is not compatible with this goal.

Secondly, at the other end of offset commodity movements, the offset projects discussed in this chapter are inadequate substitutes for structural change by large polluters in the EU ETS. Similar to the conclusion of the previous chapter, this is not to say the activities of many CDM or JI projects are not useful in climate and/or community development terms. However, the trading relationship between Tianfu and E.ON, like that between Shell and RWE, is indicative of the inherent problems of using principles of formal market equality to address a substantively unequal climate problem. While the spatio-temporal fix of the Kyoto mechanisms and their links with the EU ETS is delivered by different processes of commodification to those described in the previous chapter, the fundamental principles are the same. In this respect, the primary distinction is the greater extent of the equalisation of difference embedded in offset commodities, which is evident in the uneven levels of technological, regulatory and economic development between installations owned by E.ON and the offset projects it surrendered credits from. Carbon credits are produced by separating and objectifying project-emissions reduction relationships from their contexts and making them equal with installation-emissions relationships. By individuating out of, and abstracting from, the full set of social relations, institutions and actors involved in the appropriation of carbon, processes of commodification risk entrenching unsustainable practices, such as the fossil fuel-based electricity system that is powered by Tianfu's coal. If these factors were properly taken into account, fugitive emissions would instead be reduced at Tianfu with a plan to phase out coal mining, because failing carbon capture and storage, 88 per cent of the world's known coal reserves, including 77 per cent of that in located in China and India, need to remain in the ground to avoid global warming above 2 degrees Celsius (McGlade and Ekins, 2015: 189). Climate policy must be able to take into account the very factors that are abstracted from in processes of carbon commodification in order to make these necessary decisions.

The conceptual focus on the commodification of carbon in this and the previous chapter has been developed out of the framework developed in Part One of the thesis. By understanding carbon commodities as representations of the appropriation of carbon, the EU ETS and its links with the Kyoto mechanisms have been assessed in terms of whether the trading of carbon allowances and credits has reorganised, in a sustainable direction, the social relationships with nature that are producing climate change. The reconfiguration of time and space in the CDM and JI resonates with O'Connor's (1998: 167) notion that capitalist states tend to respond to socio-ecological crisis with attempts to "*restructure* production conditions with the aim of raising profits" (emphasis added). The restructuring of access to and use of the climate system through the commodification of carbon has thus far maintained the central place of fossil fuels as a condition of capitalist production. The EU ETS and its links with the Kyoto mechanisms have therefore functioned to avoid more fundamental restructuring of patterns of fossil fuel-intensive capital accumulation.

However, the defence of profits that this entails for the large polluters in the EU ETS has not, as flagged in the Introduction, translated to rising profits for other corporate carbon market actors. In this sense, Harvey's (2006: 442) contention that "there is, in short, no 'spatial fix' that can contain the contradictions of capitalism in the long run" appears to be playing out in the crisis of the carbon market accumulation strategy. The next and final part of the thesis adds the analytical level of the capitalisation of carbon to the conceptions of appropriation and commodification to analyse the financial aspects of carbon markets, before moving on to debates over carbon market reform. In doing so, the Chapter Six and Chapter Seven further the assessment of the efficacy of carbon markets in this thesis by focusing on the impacts of the EU ETS and its links with the Kyoto mechanisms on the broader political economic dimensions of climate change.

Part III: Capitalising carbon

6 – Carbon markets as accumulation strategy?

Introduction

Reflecting on the critical literature on the commodification of nature that informed the previous part of the thesis, Robertson (2012: 390) urges researchers to move beyond the preoccupation with exposing the category errors of delimiting and equalising different social relations with nature. The danger, according to Robertson (2012: 387), is that "we are often focused so intently on the bizarre diversity of forms in this new economy that we forget that they are united in this process of abstraction: at least in capitalism, what is circulating is not wetlands, not trees, not salmon, but *value*" (emphasis in original). This chapter analyses the distributional dynamics, trading institutions and financial innovations that have developed around the EU ETS and Kyoto mechanisms from a value theoretical perspective. The approach builds on the first two parts of the thesis by considering whether and how the commodification of representations of carbon appropriation provides a foundation to expand the accumulation of capital through the capitalisation of carbon. In concentrating on the financial winners and losers of the market-based policies, this chapter widens the assessment of the efficacy of the EU ETS and its links with the Kyoto mechanisms because changing the balance of political economic forces is a critical component of responding to climate change.

The Introduction to this thesis quoted representatives of major financial institutions who, on the back of a rapidly growing market in the years immediately following the start of the EU ETS, anticipated that carbon trading would soon be worth up to US$2 trillion per year, before eventually overtaking the size of, variously, the oil commodities market, the market in credit derivatives, or even all other global markets (Kanter, 2007; Kassenaar, 2009). However, the practical experience of carbon markets has been one of near-permanent economic crisis. Steep price crashes from highs of over €30 per tonne in the early stages of both phases one and two of the EU ETS have periodically interspersed a general decline in carbon prices, with EUAs trading at single digits for all but a handful of days since 2012 and CERs hovering at just above €0 (Intercontinental

Exchange, 2014). As a result, the peak in the *yearly* nominal value of trading volumes in carbon markets globally of US$176 billion in 2011, primarily made up of activity associated with the EU ETS, remained dwarfed by the size of other markets that financial institutions had hoped would be surpassed (World Bank, 2012: 10). By comparison, in April/the second quarter of, 2013, the average *daily* notional trading values were US$57 billion for crude oil just on the main US-based exchange and US$34 billion for credit default swaps indices alone. For foreign exchange, the world's biggest market by turnover value, daily notional trading values were US$5.3 *trillion* (Bank for International Settlements, 2013: 3; CME Group, 2013: 2; International Swaps and Derivatives Association, 2015: 23). As mentioned in the Introduction, financial institutions have responded by voting with their feet on the carbon market accumulation strategy, with Barclays, Morgan Stanley, JP Morgan and UBS, among others, joining Deutsche Bank in completely or partially winding back their carbon trading operations (Straw and Platt, 2013: 25).

Political economists have argued that the opportunities for the accumulation of capital are central to understanding why states opted for carbon markets (Böhm et al., 2012; Bumpus and Liverman, 2008; Lohmann, 2010, 2011a; Newell and Paterson, 2009, 2010; Paterson, 2010, 2012). There is indeed evidence that the UK government in particular sought to foster a carbon trading industry centred on the City of London (Department for Environment, Food, and Rural Affairs, 2003; Meckling, 2011: 109). In general, the economic possibilities for prospective, and powerful, carbon market actors certainly added weight to the case being prosecuted by Europe's polluting industries for emissions trading over alternative policy options. However, a reconsideration of these arguments is needed not only because the crisis of accumulation in carbon markets is at odds with them, but also because political economy assessments of the potential efficacy of the market-based policy approach for combating climate change – both positive and negative – have rested on the notion that carbon markets represent new sites of accumulation.

Neither the underlying basis for accumulation in carbon markets nor their apparent breakdown has been systematically studied. Ervine (2013) and Bracking (2015) discuss the grave implications of low carbon prices for climate finance initiatives, set up to support projects in developing countries, which are funded through levies on carbon trading, while Reyes (2011) characterises ongoing proposals to expand carbon markets in the context of their crisis as a case of "zombie carbon." The main exception is Felli (2014), who directly questions the viability of the carbon market accumulation strategy, in the abstract, using Marxist value theory. The existing critical literature on accumulation within carbon markets, Felli (2014: 253) argues, "has often taken the appearance of market mechanisms ('profit making') at face value, rather than questioning the social relations of production underpinning them." In particular, the literature is criticised for its lack of attention to the origin of profit in carbon markets, which Felli (2014: 267–75) argues is a form of "climate rent" that cannot expand capital accumulation because it is "predicated on a draw on surplus value." Felli's analysis, however, has a number of shortcomings. First, it doesn't engage with the practical experience, and decline, of concrete economic activity in global carbon markets. Second, owing to a rather static conception of rent, carbon markets are erroneously treated separately from capitalist production (Felli, 2014: 254).

This chapter addresses the discrepancy between the critical literature on carbon markets as accumulation strategy and the economic crisis in the financial markets built around the EU ETS and CDM. It also deepens and challenges Felli's formulation in asking whether, to what extent, and how carbon markets have supported or could support the accumulation of capital. The first section begins with an overview of the arguments made by political economists on carbon markets as new sites of accumulation. It then looks at some of the critical literature on finance to better understand the relationship between financial markets and accumulation in terms of the logic and processes of capitalisation (Bryan and Rafferty, 2006, 2011; Fine, 2010, 2013; Lapavitsas, 2009; Leyshon and Thrift, 2007). The section is closed out by a return to the Marxist literature on rent and the capitalisation of nature in order to translate these ideas to the subject of carbon markets (Marx, 1991; Moore, 2010, 2014a, 2014c; O'Connor, 1994a; Smith, 2006).

The last three sections provide an anatomy of the crisis by combining these conceptions with a close empirical examination of the opportunities for profits and accumulation in carbon markets, using the example of the EU ETS's seventh largest polluter, Luxembourg-based steel company ArcelorMittal, among other key actors and institutions. The second section considers the expropriation of carbon rent as windfall profits by focusing on the broad distributional dynamics between polluting corporations, states and consumers. The third and fourth sections focus on the financial practices that embed carbon markets by analysing the relationship between their extensive and intensive dimensions and the accumulation of capital. The chapter concludes by considering the prospects for a viable carbon market accumulation strategy underpinned by a system of capitalised carbon and its implications for addressing climate change.

Rethinking carbon markets as 'accumulation strategy'

Creating new sites of accumulation

Critical political economic analyses of carbon markets generally agree that the policy approach was driven by corporate and state imperatives to "create new sites of accumulation" (Newell and Paterson, 2009: 94). There are, however, different emphases on the nature of profits in carbon markets and their implications. For Böhm et al. and Lohmann, profits in carbon markets are underpinned by dynamics of expropriation. This conceptualisation of the basis for accumulation in carbon markets informs both of their critiques of the negative implications of carbon markets for local communities and addressing climate change.

Böhm et al. ground their analysis in an appreciation of capitalist social relations with nature. They argue that carbon markets are "the most recent development in the continuous attempt to find new opportunities for accumulation through, and from, nature" (Böhm et al., 2012: 1630). The connection between carbon markets and social relations with nature is primarily considered with respect to offset projects, where "new accumulation frontiers" align with "new forms of dispossession" for communities denied access to land, water and food (Böhm et al., 2012: 1630). In this formulation, while the particular commodities are new, profits from trading carbon ultimately derive from their role in reproducing global patterns of unsustainable, uneven development

(Böhm et al., 2012: 1632–3). Thus, for Böhm et al., accumulation in carbon markets reinforces, rather than addresses, the causes of climate change.

Lohmann (2011a: 97) adds to this understanding of the carbon market accumulation strategy by arguing that project developers expropriate the "inextricably interwoven relations between humans and their natural environment" at offset sites when they are issued carbon credits for emission reductions. This is most applicable to forestry projects that sequester or avoid carbon emissions, which are said to be predicated on a "stupendous extraction of surplus value from generations of painstaking labour" in community forest management (Lohmann, 2011a: 97). The role of the state in issuing carbon commodities is cast as the act of a "rentier" that redistributes value from the climate system as a "global public good" to corporate actors (Lohmann, 2011a: 92–3). Like Böhm et al., Lohmann (2011a: 98) links these dynamics with a negative assessment the policy, arguing "accumulation in the carbon markets takes place not through 'decarbonisation' or 'defossilisation' but through the algebra of expropriation." The inherent uncertainty of the calculation on which this expropriation is based also leads Lohmann (2010: 237) to question the sustainability of the accumulation strategy by drawing parallels with the "accumulation of 'toxic' assets" in the US housing market that precipitated the global financial crisis.

Newell and Paterson focus on the political implications of carbon markets as accumulation strategy by emphasising corporate support for climate policy that comes with the market-based approach. Their argument accords with Jessop's (1990: 198–9) understanding of state accumulation strategies as:

> A specific economic 'growth model' complete with its various extra-economic preconditions and…a general strategy appropriate to its realisation. To succeed, such a model must unify the different moments in the circuit of capital (money or banking capital, industrial capital, commercial capital) under the hegemony of one fraction (whose composition will vary inter alia with the stage of capitalist development).

Newell and Paterson identify the financial industry as the key fraction of capital in the carbon market accumulation strategy. They argue that that emissions trading in Europe was "almost unstoppable once the newly dominant financial actors realised its potential as a new market, with its derivatives, options, swaps, insurance and so on, and thus as a profitable enterprise" (Newell and Paterson, 2010: 28). Opportunities for profits and accumulation in carbon markets for the finance industry are here understood as deriving from the new areas of financial activity propelled by the policy framework. This is clear in Paterson's (2010: 361–2) response to complaints from business over the transaction costs created by carbon market regulation, in which he argues "it is precisely the methodology, and the bureaucratic steps followed, which create the value in the first place…going through stringent procedures thus creates value in the marketplace and enables a pattern of accumulation to proceed."

The power exerted by the finance industry over the adoption of carbon markets occurred without a great deal of participation in the formal policy development process. Instead, it is understood in terms of the structural power of finance in the contemporary global economy (Newell and Paterson, 2009: 82–3; Paterson, 2012: 89–90). As outlined in the Introduction to this thesis, it is the combination of this structural power of finance and the opportunities for the industry to find a new site of accumulation that shapes Newell and Paterson's argument that carbon markets could be part of a successful suite of climate policies. While recognising the shortcomings of existing carbon markets and the obstacles facing the future development of market-based policies, Newell and Paterson (2010: 10) are cautiously optimistic because the policy approach "creates the possibility of economic winners from decarbonisation. What's more, those winners – financiers – are rather powerful, and can support you as you build the policies which might produce decarbonisation overall." Thus, although Newell and Paterson draw different conclusions to Böhm et al. and Lohmann, carbon markets as accumulation strategy remains at the centre of the assessment of the efficacy of carbon markets in addressing climate change. The crisis in the global carbon market calls for each of these arguments to be revisited.

Finance and accumulation

Critical studies of finance have grappled with questions of whether expropriation and new areas of financial activity create the basis for sustainable accumulation strategies. While their insights have often been applied to issues relating to the reproduction of labour (e.g. Beggs et al., 2014; Bryan et al., 2009; Martin, 2002; Zwan, 2014), the literature is pertinent to the relationship between carbon markets and socio-ecological reproduction.

The distributional dynamic highlighted by Bohm et al. and Lohmann resembles the notion of "financial expropriation" developed by Lapavitsas (2009), along with dos Santos (2009) and Dymski (2009), to understand changes in credit markets. They argue that the withdrawal of state provision of housing, essential services and retirement incomes has forced the increased involvement of workers in the financial system and resulted in a rapid increase in household debt levels. This created new sources of profit in the realm of circulation, rather than production, through the expropriation of value from the wages of workers via interest payments, which then underpins related financial activities, such as trading in securities derived from the loans (dos Santos, 2009: 189; Lapavitsas, 2009: 115). Financial expropriation of this kind is also said to be a product of the financialisation of formerly non-financial corporations that have become increasingly independent from banks for their credit needs, which required traditional financial corporations to look for alternative sources of profit (Lapavitsas, 2009: 126). Both of these dynamics resonate with carbon markets, which are examples of the relocation of environmental policy to the market sphere, and which target increasingly financialised, traditionally non-financial, polluting corporations. Lapavitsas (2009: 138) argues that low wage growth ultimately made the source of financial expropriation "pathetically weak," which unleashed a crisis that was exacerbated by the structured assets that had been built from this weak foundation. The foundations of value in carbon markets also need to be interrogated to get a firmer understanding of the distributional dynamics highlighted by Böhm et al. and Lohmann.

Fine (2010: 100) criticises Lapavitsas' "narrow attention" on financial expropriation for missing broader effects on the restructuring of patterns of production and consumption. By doing so, Fine (2010: 101–9) concludes that what Lapavitsas identifies as financial expropriation is not novel and cannot adequately explain profits and accumulation in the finance industry. Fine (2013: 55) instead proposes that the sustainability of financialisation depends on the presence of both its "extensive" and "intensive" aspects, where the former refers to the extension of finance into new social spheres and the latter involves the proliferation of financial practices geared towards the accumulation of capital as self-expanding value. Locating intensive financial relations rests on another distinction between whether money is advanced as "simple credit" or "interest-bearing capital" (Fine, 2013: 50). The former, described as "money as money" is inherently redistributive of existing value and aligns with Lapavitsas' formulation. The latter, described as "money as capital," links financialisation and accumulation because it "requires the expansion of that wealth: production and realisation of surplus value in Marxist terms" (Fine, 2013: 49).

While the extensive dimensions of carbon markets, which involve trading a new commodity, are clear, the focus on intensive financialisation has important implications for understanding the viability of carbon markets as accumulation strategy. Citing an example that is relevant for the subject of this thesis, Fine (2013: 55–6) argues that the marketisation of water "is not in and of itself financialisation…despite the heavier presence of, and opportunities for, (private) finance." Instead, stressing the importance of intensive financial relations:

> Financialisation depends on how such expansion of financial activity straddles the boundaries between [interest-bearing capital] and other forms of capital in exchange: is it merely an expansion of credit or does it involve a requirement of surplus production and appropriation beyond what would be expected of 'normal' commercial activity?

Newell and Paterson's analysis of accumulation strategies within carbon markets have largely focused on the existence of new opportunities for financial activity. Fine's formulation provides a basis for reconsidering the sustainability of carbon market profits by looking at the relationship between the new financial activity generated and the underlying logic and process of capitalist expansion.

Combining the extensive and intensive aspects of financialisation depends on creating new assets that can store value or deliver income streams (Bryan and Rafferty, 2011: 207–12). This is characterised by Leyshon and Thrift (2007: 98) as the "capitalisation of almost everything," which they define as "a fresh round of tracing value to its source – or rather sources – since what we can see now is an impulse to identify almost anything that might provide a stable source of income." Leyshon and Thrift's focus is on the way in which these new assets can be capitalised by leveraging their values or incomes streams to increase trading and investment (Leyshon and Thrift, 2007: 99–100). Often, the 'new' asset is found through the disaggregation and re-aggregation of existing operations, which Leyshon and Thrift (2007: 101) link to advances in information technologies. Whether financial innovations in carbon markets have successfully created leveragable assets is an important test for the capitalisation of carbon.

Lastly, Bryan and Rafferty advance understandings of the relationship between financial markets and accumulation by focusing on the rise of derivatives linked to new financial assets. Derivatives are financial instruments that provide exposure to the performance of an asset, measured by movements in prices or indices, without the need to own or buy the underlying asset. The instruments are used to manage the risks of such movements for future profits as well as to profit from them (Bryan and Rafferty, 2011: 199–200). Bryan and Rafferty (2006: 12) argue the capacity of derivatives to "blend different forms of capital into a single unit of measure" and "'bind' the future to the present" intensifies capitalist competition. Taken together, as a "system of derivatives," the blending and binding capacity of derivative subjects all underlying assets to calculative practices that constantly compare and contest their relative performance (Bryan and Rafferty, 2006: 17–18). Capitalisation, in this account, is a logic and process of disciplinary pressure exerted by derivatives on underlying assets – inside or outside the boundaries of the corporation – to perform as self-expanding capital. For Bryan and Rafferty (2006: 162), the pressure to remain competitive ultimately falls on labour. Combining Bryan and Rafferty's insights with the theoretical framework of this thesis opens up the question of whether and how carbon markets shape, rather than simply draw on, as Felli asserts, the production of surplus value by disciplining the appropriation of carbon.

Capitalising nature

Although they have competing positions on its character, each of these critical perspectives on finance is concerned with questions of underlying value in financial markets. Marxist rent theory is useful for translating these debates to the subject of carbon markets because it conceptualises the circulation of value specifically from the commodification of nature. Marx conceptualises value captured by virtue of control over and access to the productive forces of nature as 'rent'. In relation to land, Marx (1991: 959) argues:

> Just as the functioning capitalist pumps out surplus labour from the worker, and thus surplus-value and surplus product in the form of profit, so the landowner pumps out a part of this surplus-value or surplus profit in turn from the capitalist in the form of rent.

According to Marx there are two conditions for the expropriation of rent. The first is whether the "natural forces can be monopolised" and the second is whether they "give the industrialist who makes use of them a surplus profit" (Marx, 1991: 908). Monopolisation creates scarcity and excludability. If scarce and excludable natural conditions are to command a rent, their appropriation must be necessary to increase surplus value production.

In carbon markets, possibilities for the expropriation of value, and its capitalisation, fundamentally depend on the relationship between these two conditions of rent. Rent in carbon markets is underpinned by the appropriation of carbon, which, as discussed in Part One of the thesis, is a process that involves the augmentation of surplus value by enhancing the productivity of labour in carbon-intensive production processes. In the EU ETS, the circulation of value as rent in carbon commodities is achieved through the monopolisation of relationships between installations and emissions by the processes of individuation, privatisation and abstraction discussed in Part Two. These processes relate to scarcity and excludability by determining the scale and scope of value captured in carbon commodities.

Smith (2006: 20–1) posits that market-based policies such as carbon markets harness rents to create a "capitalised nature" out of commodities that are "excavated (in exchange-value terms) from pre-existing socio-natural relations." This argument was anticipated 20 years earlier by Martin O'Connor (1994a: 55), who described the "capitalisation of nature" as:

> The diverse elements of nature (including human nature) themselves codified as capital. Nature is capital, or, rather, nature is conceived in the image of capital. The logic of the system is thus the capitalisation of all of the elements of nature-considered-as-capital to the finality of capital's expanded reproduction.

Smith (2006: 38) conceptualises the relationship between the capitalisation of nature and the expanded accumulation of capital as "the vertical integration of nature into capital," a two-way movement involving the "production of nature 'all the way down'" and "its simultaneous financialisation 'all the way up'." By this, Smith (2006: 33) is referring to the increasing power of financial markets to decide, according to the capitalist calculative logic of profitability, precisely what, how, how much, when and where nature is appropriated and, relatedly, the circulation of bits of nature as part of the total social capital in financial markets. Like the critical finance literature, this work on the capitalisation of nature is therefore interested in the extensive and intensive spread of financial relations in new areas of commodification, paying close attention to the segmentation of value, imperatives for expanded accumulation and the intensification of capitalist social relations. Prospects for the capitalisation of nature in carbon markets, understood in these terms, have important implications for the general processes that Smith (2006: 20) and Martin O'Connor are discussing, as one of the most significant iterations of the broader project of "ecological commodification, marketisation and financialisation."

Moore has stressed, however, that capitalised nature is not free from contradictions, due to the particular relationship between value and nature under capitalism. Chapter Two described how capital 'freely' appropriates nature because its productive forces are not valued under capitalism in terms of abstract social labour (Burkett, 1999: 76). Moore (2014c: 288) develops this idea by characterising the relationship between capitalism and its natural conditions as the perpetual search for "cheap" nature that can be appropriated in order to reduce socially necessary labour time, and therefore increase surplus value production. Stressing the importance of cheap nature for capitalist accumulation, Moore (2010: 400–1) contends that "historically, the secret of capitalism's success has been to maintain strict limits on the extent of capitalised nature. Capital's first preference is to appropriate nature, rather than to produce it through the circuit of capital" (see also Fraser, 2014: 66). The expansion of zones of capitalised of nature is problematic if it limits the scope to appropriate cheap nature. This is why Moore (2010: 408) argues that capital's:

> Tendency to dissolve socio-ecological particularities and reconstitute them as 'interchangeable parts'…tends to enable the accumulation of capital for a time, but, in the absence of uncapitalised nature, is unsustainable within the logic of capital accumulation itself.

The sustainability of the capitalisation of nature therefore hinges on maintaining, and increasing, the appropriation of nature (Moore, 2014c: 303).

This calls for a dynamic conception of carbon rent that is constituted by financial practices in carbon markets. Robertson (2012: 389) warns against viewing new areas of nature's commodification as "simply the search for profit in a fixed and existing world." Robertson is responding to Marxist analyses that proceed according to sharp distinctions between actors and activities that do and don't produce value, which fails to appreciate value producing labour as a social relation *between* humans and nature. While Felli (2014: 268) quite rightly argues no socially necessary labour time is involved in the creation of a carbon commodity, this does not discount an active role of carbon markets in shaping the production of value in fossil fuel-intensive labour processes. Rather, the success of the carbon market accumulation strategy is integrally linked to the multilevel relationship between the appropriation, commodification and capitalisation of carbon. The next three sections draw on this work on the capitalisation of nature, combined with that on financial expropriation, and the extensive and intensive aspects of financialisation, to analyse accumulation in carbon markets in terms of windfall profits, new financial relations and carbon as capital.

Expropriating carbon rent: Windfall profits

The initial distribution of carbon rent is determined by the extent of free allocation vis-à-vis auctioning. Auctioning allows states to expropriate carbon rent, whereas in freely allocating allowances, states redistribute this value back to capital. Prior to the commodification of carbon, capital appropriated the value that now takes the form of rent. But separating part of that value as rent through the commodity form allows nominal costs of carbon allowances to be passed on to consumers through higher prices. A range of econometric and other modelling techniques have been employed to show that companies in both the electricity and gas and other carbon-intensive industries have indeed increased their prices to incorporate the cost – whether actually incurred or the opportunity cost of not selling – of carbon allowances (Laing et al., 2014: 513–5). The price increases have covered all, or a substantial majority of, the costs. Using a model for 20 European countries, Lise et al. (2010) estimate the rate of cost pass on for the electricity and gas industry is between 70 and 90 per cent in most cases. Likewise, Sijm et al. (2006), observing forward and spot prices in German and Dutch electricity markets, estimate cost pass on levels of between 60 and 100 per cent. Similar results have been found in the oil refinery, iron and steel, chemical and cement industries, despite these industries claiming an inability to pass on costs due to international competition (de Bruyn et al., 2010; Okereke and McDaniels, 2012; Smale et al., 2006).

Given the vast majority of allowances were freely allocated in phases one and two of the scheme, companies that were able to pass on most or all of the value of carbon allowances enjoyed windfall profits. For example, Ellerman et al. (2010: 326) calculated windfall profits from increased prices to be €11 billion for fossil fuel-based electricity generation in phase one of the scheme. Despite having a smaller share of overall emissions than the sector, de Bruyn et al. (2010: 60) estimate that other energy intensive industries gained windfall profits of around €14 billion, inclusive of the first year of phase two, from 2005 to 2008. Modelling for the second phase of the scheme projected an increase in windfall profits to between €23 and €71 billion, although the actual figure is likely to be less than this given carbon prices were much lower than the €21-32 per tonne the estimate was based on (Point Carbon, 2008).

The disproportionate windfall profits to manufacturing industries, given the lower share of emissions, are a product of not just free allocation, but over-allocation. Whether over-allocation is defined in terms of levels of free allocation relative to business as usual or emissions goals (Ellerman and Buchner, 2008), companies in energy-intensive manufacturing industries benefitted from allocation levels well in excess of both definitions. This generated windfall profits not just from passing on costs of allowances surrendered but also by selling surplus allowances. The uneven distribution of emissions translated to the uneven distribution of surplus allowances between companies, which saw many of the biggest polluters gain the biggest windfall profits.

Table 6.1: Top 10 ultimate owners by 2005-12 allowance surplus

Ultimate owner	**2005-12 allowance surplus (Mt CO_2-e)**	**% of allocation**	**NACE Rev.2 sector**
ArcelorMittal SA	215	31%	Manufacture of basic iron and steel and of ferro-alloys
Tata Steel Limited	82	31%	Manufacture of basic iron and steel and of ferro-alloys
Lafarge SA	49	25%	Manufacture of cement
ThyssenKrupp AG	39	25%	Manufacture of basic iron and steel and of ferro-alloys
SSAB AB	34	36%	Manufacture of basic iron and steel and of ferro-alloys
Government of the Czech Republic	33	10%	Electric power generation, transmission and distribution
HeidelbergCement AG	31	18%	Manufacture of cement
CEMEX SAB de CV	24	23%	Manufacture of cement
HKM GmbH	23	39%	Manufacture of basic iron and steel and of ferro-alloys
Total SA	23	12%	Manufacture of refined petroleum products

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 6.1 lists the ten ultimate owners that accrued the largest allowance surpluses in absolute terms between 2005 and 2012. All are in the top 75 largest polluting ultimate owners, which Chapter Three showed account for 75 per cent of all EU ETS emissions. Combined, their 553 million surplus allowances represent 35 per cent of the total surpluses accrued by the 2,695 ultimate owners that registered overall allowance surpluses. On average, levels of allocation to the top ten surplus holders represented 25 per cent more than their verified emissions. The sectoral breakdown reveals that eight of the ten are steel or cement companies.

Problems in the transparency of reporting and the consistency of accounting (see Lovell, 2013; Lovell et al., 2010, 2013) makes calculation and comparison of the precise profits attained from allowance surpluses difficult for many companies. Nevertheless, ArcelorMittal, the company with the largest overall surplus, demonstrates the upper end of the magnitude of profits. Between 2009 and 2012, the company reported a total of US$508 million in net profits from the sale of carbon allowances and credits (ArcelorMittal, 2010b: 53, 2011: 40, 2013: 92). This figure doesn't include profits from the sale of phase one surpluses or the value of carbon allowances banked for future use or sale. The level of banking is likely to be substantial, as ArcelorMittal-linked accounts physically traded 93 million allowances and credits to external accounts between 2005 and April 2011, less than half of the company's overall phase one and two surplus. The external accounts ArcelorMittal sold allowances to include electricity companies such as GDF Suez, EDP, EDF, and KSBG and financial institutions such as Barclays, BNP Paribas, Goldman Sachs, Morgan Stanley and Deutsche Bank (European Commission, 2014i).

Table 6.2: 2005-12 allowance surpluses by general sector

General sector (NACE Rev.2)	**2005-12 surplus/deficit (Mt CO_2-e)**
Manufacturing	1,188
Electricity, gas, steam and air conditioning supply	-893

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Whether sold directly to polluting companies, or via financial institutions, demand for surplus allowances from ArcelorMittal and other manufacturing companies ultimately came from the generally under-allocated electricity industry. In turn, due to the ability of electricity companies to pass on costs, the profits from this mostly came from end consumers. The allowance allocation imbalance underpinning this distributive outcome is shown in Table 6.2. It compares the surpluses and deficits of the electricity and manufacturing industries, the two general sectors that account for 98 per cent of all EU ETS emissions, for 2005-12. Overall, the deficit of the electricity sector comprised 75 per cent of the surplus of manufacturers.

Thus, although the electricity industry deficit was a source of windfall profits for the over-allocated manufacturing sector, value circulating through carbon commodities was dispersed by the general surplus of allowances in the EU ETS as a whole. This surplus, a product of both the impact of the economic crisis on the underlying source of value, and the failure to stringently monopolise that value due to general over-allocation, ultimately limited the expropriation of carbon rent as windfall profits. This is evident in the windfall profits from the sale of surplus allowances reported by ArcelorMittal (2015: 90) more recently, which fell from an average of US$127 million per year from 2009 to 2012 to US$32 and US$14 million in 2013 and 2014. This fall was well below the impact of slightly reduced levels of free allocation to the company in phase three of the EU ETS (European Commission, 2015c).

The change in the method of allocation from free to auctioned allowances also limits post-2012 windfall profits for corporations. As outlined in Chapter Four, the EU ETS has gradually moved towards auctioning allowances, primarily for the electricity sector, from the beginning of phase three. Under the new regime, the iron and steel sector is projected to have an allowance deficit, though smaller than its previously accrued surplus, while the cement industry remains likely to increase its surplus (Morris, 2014: 44–51). With auctioning, increased prices as a result of cost pass through covers actual allowance costs, rather than opportunity costs, for capital and carbon rents are instead expropriated by states. The auctioning of allowances for the first two years of phase three, 2013 and 2014, generated revenues for states of €7 billion (Department of Energy and Climate Change, 2014: 1–2; European Commission, 2014c: 4–5; German Emissions Trading Authority, 2012: 7, 2014: 6, 2015: 5). 88 per cent of this revenue is distributed among states according to their share of 2005 verified emissions, while 12 per cent is earmarked for distribution among new member states (European Commission, 2014b).

The increase in auctioning has been introduced alongside provisions for industry compensation for the cost of allowances. The EU ETS Directive was amended to call for 50 per cent of auction revenues to be used in domestic or international climate change programs from phase three (European Parliament and Council, 2014: Article 10). But the EU's 'state aid' rules, which regulate the use of subsidies in the EU, were also amended to allow compensation for carbon-intensive manufacturing industries deemed at risk of 'carbon leakage' from increased electricity prices and for owners of fossil fuel power stations deemed to be ready to adopt carbon capture and storage technology, from the same start time (European Commission, 2012d). Compensation provisions have been criticised by NGOs that argue the levels of compensation granted are based on overly inflated carbon prices, unsubstantiated risks of capital flight and are directed toward industries that already have substantial allowance surpluses (Perez and Mowat, 2013; Reyes, 2012). The financial effect of compensation is to redistribute carbon rent lost from the shift to auctioning back to capital. For example, Germany's compensation plan for 2014, approved by the European Commission, totalled €350 million. This is almost half of the €750 million in auctioning revenues the German government received in the same year (European Commission, 2013d; Federal Ministry for Economy Affairs and Energy, 2012; German Emissions Trading Authority, 2015).

In sum, participation in the EU ETS has generated profits for all major polluting actors as a result of passing on the costs of freely allocated allowances and selling surplus allowances. These profits have somewhat diminished over time with the shift to greater levels of auctioning and the generalised problem of over-allocation. The distributional dynamics of profits of this kind are a different form of expropriation to that identified by Böhm et al. and Lohmann in relation to offset projects; it can be understood using Lapavitsas' notion of 'financial expropriation', because value underpinned by the appropriation of carbon is expropriated by capital within the sphere of circulation from consumers through higher prices. For Lapavitsas (2009: 132), financial expropriation is made possible by the compulsion of the financial system for the social reproduction of workers. Compulsion in the EU ETS is created by the commodification processes that force corporations to surrender allowances or credits in order to appropriate carbon. As with household incomes, the underlying source of value on carbon markets has been weakened over the course of the economic crisis, which reduced levels of carbon appropriation and subsequently, levels of carbon rent. Further, states failed to make the force of compulsion sufficiently strong by setting a stringent-enough cap. In any case, however profitable the expropriation of carbon rents has been for certain private interests, the implications for broader processes of capital accumulation need to be considered in the context of the new financial relations that shape their realisation.

Extensive carbon: New financial relations

A multiplicity of financial practices and institutions have emerged not just to facilitate compliance, but also to manage financial risk and make profits, both for regulated and non-regulated companies. Studies of financial practices within carbon markets have demonstrated that they tend to operate within the norms of already established financial architecture. Descheneau and Paterson (2011: 672–3) highlight attempts to establish services that rate the risk of different carbon offset projects in ways that mimic credit ratings agencies, as well as the availability of a range of instruments such as futures, options and swaps that are common to other financial markets. Knox-Hayes (2009) also stresses complementarities with existing financial markets as the driving force for the concentration of carbon trading services in financial centres such as the City of London. The analysis in this section of how and why carbon is traded accords with the notion that financial practices in carbon markets are "routinised" by "borrowing" from existing financial markets (Descheneau and Paterson, 2011: 672). Its focus is on whether the extension of those practices to create new areas of financial activity represents a sustainable accumulation strategy.

Carbon allowances and credits are traded in spot, futures and options markets. The spot market, which involves the almost immediate purchase and physical delivery of allowances, is the smallest, accounting for only 2 per cent of trading value in 2011 (World Bank, 2012: 32). This was well below the 22 per cent of total trading volume registered in 2009. The decline was firstly a result of efforts to block fraudulent trading that was inflating spot volumes. In these fraudulent practices, allowances and credits were sold by traders with value added tax (VAT), who would then disappear before the tax was due to be paid to the government and pocket the tax revenue. According to

Europol, this cost governments €5 billion and accounted for up to 90 per cent of spot trading volume in certain periods (Europol, 2009; Frunza et al., 2011). Secondly, regular spot volumes declined because of the heightened risks in spot trading compared with longer term financial instruments, due to the risk of buying allowances that were ineligible because they had been stolen from registries in a series of computer hacking scandals and phishing scams (World Bank, 2010: 9, 2011: 40).

The second most common type of trade is an option. Carbon option trades grew from 1 per cent of trading value in 2008 to 10 per cent in 2011 (World Bank, 2012: 32). Options are contracts that give an actor the right to buy (known as a 'call') or sell (known as a 'put') a quantity of allowances at a point in the future (World Bank, 2010: 16–7). The most common type of trade is a future, which in 2011 made up 88 per cent of the total value of transactions (World Bank, 2012: 32). Futures are contracts that arrange the delivery and payment of a quantity of allowances at a specified future date, usually in December, to coincide with emissions auditing as well as the end of the financial year (Chevallier, 2011: 101; Daskalakis et al., 2009: 1232; Environmental Finance, 2009; Frino et al., 2010: 104). Each of these contracts may also take the form of swaps between CERs/ERUs and EUAs (World Bank, 2008: 65).

The different carbon instruments are traded in a variety of settings, including exchanges, over-the-counter and bilaterally. Exchange platforms offer generic spot, options and futures contracts which reduce risk because the exchange acts as the direct counterparty for both buyer and seller, guaranteeing delivery of, and payment for, carbon commodities (Ellerman and Joskow, 2008: 50). Over-the-counter and bilateral trades tend to involve larger contracts that are more tailored to the parties involved than with exchanges. In bilateral and over-the-counter trades, a contract for future delivery is known as a forward. The latter are mediated by carbon brokers while the former occur direct between buyer and seller (Ellerman et al., 2010: 131–2).

During the first phase of the EU ETS, over-the-counter trades were dominant, but exchange-mediated trades became most common over the course of phase two, representing 49 per cent of the trading value of EUAs, CERs and ERUs, excluding government auctions, in 2011 (World Bank, 2012: 33). Most exchange-traded futures contracts (85% in 2013) occur at London's European Climate Exchange, which became part of the Intercontinental Exchange (ICE) Futures Europe platform, a major exchange that hosts other commodity, interest rate and currency trading, in 2010 (Grant and Weitzman, 2010; Pell, 2014). Exchange-traded spot carbon was primarily traded on the Bluenext exchange in Paris, which was jointly owned by New York Stock Exchange Euronext and French state-owned bank Caisse des Dépôts et Consignations (CDC) until it shut down at the end of phase two, after sustaining losses from tax fraud and theft, and failing in its bid to manage phase three government auctions (Mizrach and Otsubo, 2014: 108; Vitelli, 2012). Exchanges are involved in a larger proportion of trades in carbon markets compared with other markets (Point Carbon, 2010b). Indeed, the majority of over-the-counter trades, which accounted for 39 per cent of carbon trading value in 2011, were nonetheless cleared by exchanges for additional security (World Bank, 2012: 33). In 2011, 12 per cent of trading value occurred bilaterally, often involving power companies with their own trading desks (Kalaitzoglou and Ibrahim, 2013: 630; World Bank, 2012: 33). Due to the heterogeneity of offset projects, primary market (i.e. the initial purchase of carbon credits from project developers) trades occur over-the-counter or bilaterally, and follow the terms set out in contracts known as emissions reduction purchase agreements (ERPAs) (World Bank, 2008: 61).

Carbon trading is driven by the particular risks that stem from the interplay between and within the underlying source of value in carbon markets and the political factors that determine the capture of carbon rents. The hedging practices of electricity companies drive a large proportion of trading activity. Power companies sell much of their electricity in contracts up to three or four years in advance. In conjunction with securing their coal, gas and oil fuel needs, the companies purchase forwards, futures or call options on European allowances or offset credits to cover their expected emissions, which locks in profits irrespective of upwards carbon and fuel price movements (Fan et al., 2014: 76–7; Neuhoff et al., 2012: 2). The allowance deficit position of most electricity companies, together with their existing experience in financial markets, produces more active trading from the sector compared to manufacturers.

However, the case of ArcelorMittal shows that large manufacturing companies also actively trade. The company states it "enters into certain types of derivatives" on carbon to hedge against the risks of price movements to the cash flow from the sale of surplus allowances (ArcelorMittal, 2010a: 49). To manage these risks, in 2008 and 2009 ArcelorMittal (2010a: 49) had net notional positions, respectively, of $171 million and $162 million for carbon derivatives. These derivatives may, for example, have been entered into with a counterparty that was short in its allowance allocation, such as a power company, to reduce respective risks of downward and upward carbon price movements. While this is an example of trading activity where the exposure is to price movements, rather than ownership, of carbon commodities, most carbon trading is settled with physical delivery rather than cash, reflecting the underlying compliance dimensions driving trading in the EU ETS (BNP Paribus Fortis, 2009: 70).

Carbon allowances and credits have also been securitised in structures shaped by the particularities of carbon markets. For example, securities have been developed where carbon allowances are structured in tranches with different maturities to be progressively delivered in line with yearly compliance requirements. Brokerage company, Tradition, structured the first reported phase three allowance trade, between Gunvor, which owns an oil refinery in Ingolstadt, Germany and investment bank JP Morgan, in this way. The contract involved delivery of allowances on a number of dates between 2013 and 2020 and was cleared on the European Climate Exchange (Szabo, 2010). Similarly, securities in offset credits have been developed in response to the price risk of general over-issuance of credits relative to overall demand, delivery risk from under-issuance of credits for individual projects – only about 31 per cent of CERs have been issued on time (Cormier and Bellassen, 2013) – and political risk of changes to project type and country eligibility rules. Carbon funds structure such contracts in ways that sell credits from a pool of projects of different types and locations. For example, Camco, the seventh most active CDM project participant with 148 projects involving 11 project types in seven countries, offers securitised contracts of this kind that are internally divided by tranches of projects with different levels of risk (Camco, 2009; Fenhann, 2014a). Each of the financial institutions cited here that are involved in these more complex contracts have suffered economically in recent years. Both JP Morgan and Tradition have since scaled back their carbon trading operations, with the latter citing falling carbon prices for the trend (Straw and Platt, 2013: 25; Vitelli and

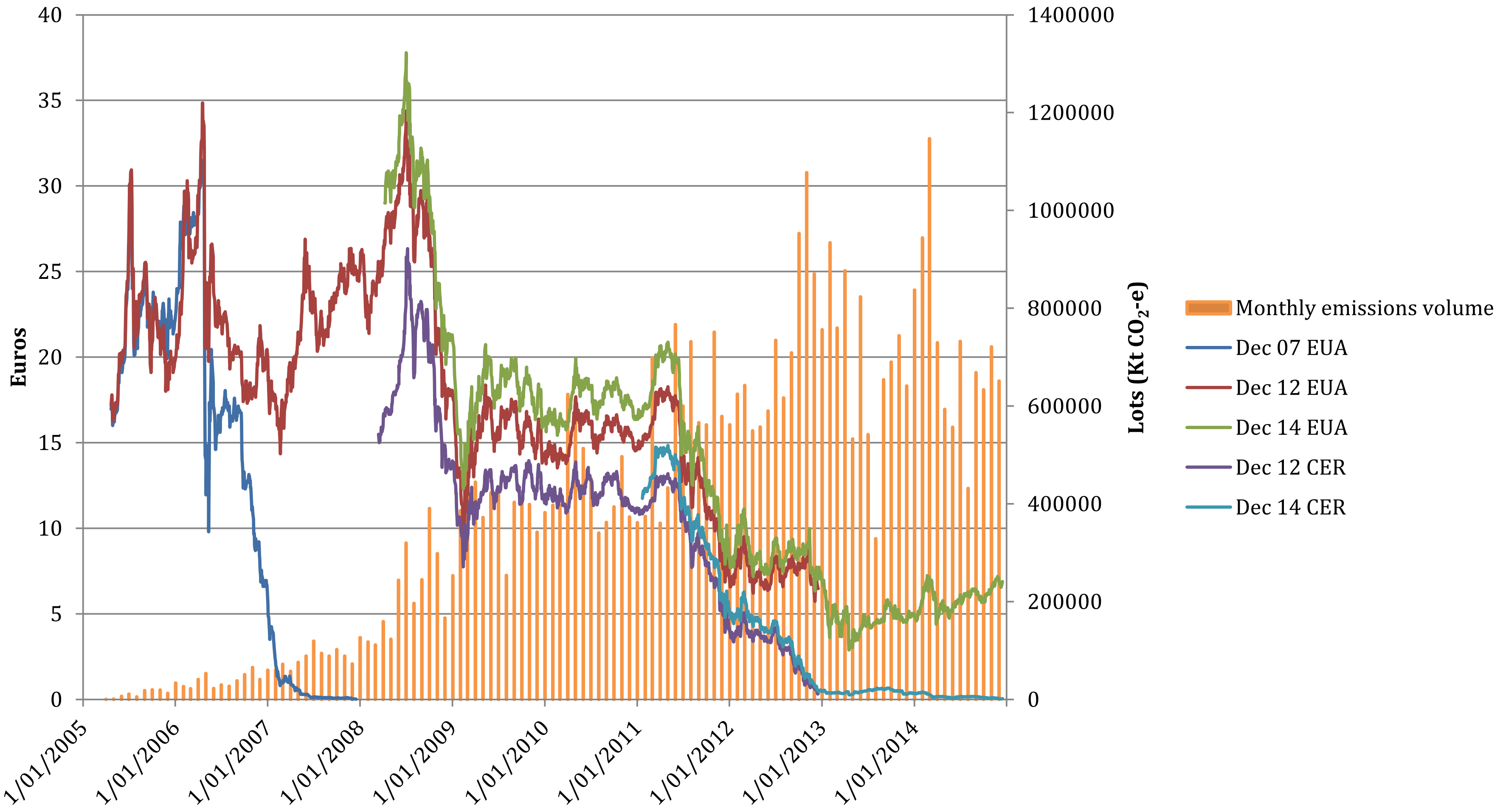
Carr, 2013). Camco also suffered heavy losses following the write-down of the value of its CER portfolio (Kouchakji, 2013).

Political and regulatory factors therefore create risk that both drives trading activity and threatens profits (Chevallier, 2011: 109; Conrad et al., 2012: 317–18). This was witnessed in the two largest volume trading days up until the end of 2014 on the European Climate Exchange, 27 and 28 March 2014. Trading activity on those days was propelled by anticipation of the annual publication of verified emissions on 1 April by the European Commission, which indicates levels of immediate demand for carbon commodities. In the lead up, private analysts forecasted lower than expected emissions, prompting speculative trading by financial actors, the unwinding of hedges by electricity and rushed selling of surplus allowances by industrial actors. The behaviour both anticipated, and helped realise, a price decline for European allowances from a high of €5.90 on 27 March to a low of €3.71 on 28 March, for December 2014 contracts (Intercontinental Exchange, 2014; Szabo, 2014). The allowance price had been pushed up in the months prior to this event by the decision to withhold the auctioning of 900 million allowances in phase three, which is discussed in detail in the next chapter. Trading in the lead up to one of the many votes on this issue illustrates the role of political decisions in driving financial activity and associated volatility. Just prior to the vote of the European Parliament's Industry, Research and Energy committee in February 2012, options trading on the European Climate Exchange substantially increased, with traders placing call options up to €35 and put options at below €5, compared to the then price of €8.50 for December 2012 contracts (Intercontinental Exchange, 2014; Point Carbon, 2012). As will be discussed in the next chapter, however, carbon market actors have become increasingly wary of volatility driven by political decisions, because while profits can be made from upwards and downwards price movements, such risks are viewed as difficult to predict and therefore manage.

The forms and reasons for trading carbon highlighted in this section have combined to increase trading volumes while carbon prices have fallen. In 2005, only 15 per cent of total allocated allowances were traded (World Bank, 2006: 14). In the four years to 2011, the rate of allowance turnover increased to 324 per cent of the total allocation (World Bank, 2014b: 73). Figure 6.1 illustrates this in more detail by showing carbon prices and trading volumes on the dominant European Climate Exchange since 2005. Trading on the exchange more than doubled each year in the first phase of the EU ETS and the first year of the second phase. In phase one, EUA futures for delivery in December 2007 hit a high of €31.50 in April 2006. The contracts then halved their price in two weeks with the release of 2005 verified emissions data and hovered around €1 for most of 2007 when the endemic nature of the allowance surplus in the context of the inability to bank allowances into 2008 became unquestionable. In the second phase of the EU ETS, trading volumes on the European Climate Exchange continued to grow by an average of over one-third per year from 2009 to 2012. In phase two, 2012 EUA futures again reached highs of €34.38 in July 2008 before crashing over the European winter of 2008-9 to levels to as low as €9.43 as a result of the lower emissions that came with reduced production levels in a recessionary economy. After a short price recovery, EUA futures have largely traded for single Euro digits since 2012, while even greater levels of oversupply in offset markets has seen CERs fall and remain close to zero (Intercontinental Exchange, 2014).

However, increasing volumes, such as those experienced on the European Climate Exchange, have not been able to offset the decline in the overall value of carbon market transactions. Bloomberg attributed the 2011 peak in the transaction value of global carbon markets, which it calculated to be €92 billion, to a 22 per cent increase in transaction volume that offset the 10 per cent average decline in carbon prices that year (Bloomberg New Energy Finance, 2012). Since then, increases in trading volumes of 26 per cent in 2012 and 10 per cent in 2013 were unable to arrest the decline in transaction value to €61 billion and €40 billion, respectively, as mentioned in the Introduction to this thesis (Bloomberg New Energy Finance, 2013a, 2014). In 2014, low carbon prices began to take their toll on volume too, with trading of European allowances falling by 5 per cent over the year for the first time (Carr, 2015). This may reflect a point at which the cost per allowance or credit is so low that risks associated with price movements have dissipated to a point where hedging is less necessary for compliance actors, while taking an open position large enough to justify speculation is not financially worthwhile for other actors.

Figure 6.1: European Climate Exchange carbon prices and trading volumes 2005-14



Source: Intercontinental Exchange (2014). Note: 2014 volumes include electricity and coal lots.

Taking stock, the extension of financial relations by carbon markets – emphasised by Newell and Paterson as being at the core of the accumulation strategy – has indeed created new economic opportunities for financial institutions. These practices have also supported the realisation of windfall profits for polluting corporations discussed in the previous section. But as with windfall profits from the expropriation of carbon rent, opportunities to profit from new financial activity have shrunk with the fall in the value of carbon rents circulating through carbon commodities. Following Fine, the 'extensive' aspect of the carbon market accumulation strategy hasn't been sustained on its own terms. The next section develops a fuller assessment of the relationship between carbon markets and capitalist expansion by adding consideration of the 'intensive' capitalisation of carbon.

Intensive carbon: Carbon as capital?

In the early stages of the EU ETS, there was great enthusiasm among corporate actors for the prospects of developing financial instruments out of carbon markets that could intensify trading and investment. In a survey conducted in the first year of the EU ETS, actors representing energy companies, banks and exchanges expressed high levels of support for the idea that carbon commodities represent a good underlying asset for the development of a range of financial instruments (Uhrig-Homburg and Wagner, 2008: 645). By January 2006, there were signs these expectations were beginning to materialise. For example, the head of environmental markets at Fortis Bank reported that:

> Yesterday gave us a real taste of the year to come. A minute fraction of the total pool of EUAs was monetised through a 14 month [repurchase agreement]. Simply put, a corporate net received about €50 million, to be used as working capital, for 3.3 million EUAs, which they will get back in time for compliance in 2007…We can expect a reasonable percentage of first period allowances, worth some €150 billion, to be monetised and/or start serving as collateral. This is a turning point in the valuation of carbon. *Carbon is capital*, and well on track to become a European hard currency (Walhain, 2006 emphasis added).

In proclaiming "carbon is capital," the banker heralded the subsumption of the carbon commodity to the logic of capitalist expansion through monetisation in this instance, but also predicting imminent collateralisation. This section examines each of these paths to the capitalisation of carbon in turn.

Monetisation deals such as the one described by Fortis make use of the annual compliance cycle of the EU ETS. Allowances are allocated in February each year but don't need to be surrendered for compliance until April in the following year. Companies therefore have allowances in their possession for 14 months before they need to be surrendered. The repurchase agreement was able to monetise the value of allowances for the polluting company over that period. The yearly overlap between allocation and surrender dates makes it possible to extend monetisation practices well beyond 14 months. Because companies have the current year's allocation in their possession before the allowances to comply with the previous year's emissions need to be surrendered, and banking provisions abstract from the year of allocation, companies don't need to repurchase allowances after 14 months because they can instead surrender that year's allocation for the previous year's emissions. With full inter-phase bankability from phase two, this practice could in principle continue as long as free allowance allocation continued.

A confluence of factors at the beginning of phase two made this use of the compliance cycle particularly significant. The tight credit environment that developed with the onset of the crisis and the threat of the end of free allocations for power companies from phase three saw the carbon market take on some of the features of a credit market. Companies, especially in the steel and cement industries that were hit particularly hard by the crisis, sold their 2008 or 2009 allocations on the spot market and bought 2012 options and futures, with a plan to roll over their yearly allocations in between (the 2012 date was a product of uncertainty over post-2012 allocations for all actors) (World Bank, 2010: 10). This practice is another reason for the higher levels of spot market trading in the early part of phase two, which increased by 75 times between the first half of 2008 and the first half of 2009 (World Bank, 2010: 8).

For sellers of allowances, monetisation of 2008 and 2009 allowances on spot markets and the purchase of 2012 contracts represented a more attractive loan than was otherwise available. Until November 2008, the premium paid over the spot price for a future to be delivered in 2012 was below the Euribor interest rate at which banks lend and borrow to other banks. After that, and through 2009, the cost of this 'loan' increased to well above the Euribor as the selling of over-allocated allowances pushed spot prices down, and power companies seeking allowances to bank into phase three pushed futures prices up (CDC Climat, 2009). Still, some companies with poor cash flow and lack of access to other types of credit continued to make use of this practice (World Bank, 2010: 10). Returning to the example of ArcelorMittal illustrates the upper end of the 'credit' that could be raised by selling one year's worth of freely allocated allowances. With 2008 EU spot prices reaching up to €25.00, ArcelorMittal's 2008 allocation of 88.7 million EUAs was at times worth over €2 billion (European Environment Agency, 2012).

For buyers of spot allowances, there were opportunities to profit from arbitraging between the price difference of spot and 2012 contracts, which as outlined yielded a high return for most of 2009 (CDC Climat, 2009; World Bank, 2014b: 74). Further, in this period, spot purchases were also driven by expectations of increasing carbon prices. The expectations are reflected in price forecasts by analysts from banks and speciality services. In April 2008, when the spot EUA price was around €23, the average second phase price forecast by Deutsche Bank, Point Carbon, Fortis, Société Générale and New Carbon Finance was €32 (Reuters, 2008). Almost a year later, despite reducing their 2009 price forecasts to €14 as the full extent of the crisis became clearer, EUA prices, on average, were still expected to reach on average €25 at the end of 2012 by analysts at Barclays, Citigroup, Daiwa, Deutsche Bank, Sagacarbon, Société Générale, Point Carbon and UBS, with Point Carbon and UBS predicting €35 per tonne (Chestney, 2009b). Thus, some buyers would have expected to profit from an appreciation in the price of carbon allowances and credits as assets.

Innovative uses of the EU ETS compliance cycle have indeed seen the successful monetisation of carbon. Carbon as money may become 'money as capital', as understood by Fine, if invested to augment accumulation. The role of the compliance cycle in structuring the monetisation of carbon may actually encourage capitalist expansion due to the compulsion to buy EUAs and CERs/ERUs at a higher price in the future. The capacity to do so is integrally linked to the production of surplus value through the appropriation of carbon that results in greenhouse gas emissions, which necessitates compliance. Although carbon allowances are not interest-bearing assets as such, the compliance cycle could be used to deliver future income streams for financial actors from yearly forward sales. Therefore, due to the particular characteristics of the EU ETS, strategies associated with monetising carbon may engender financial imperatives that take on the logic of interest-bearing capital. Such imperatives, however, decrease with low and declining carbon prices. The maximum spot value of ArcelorMittal's 2012 allocation of 87 million allowances had declined to €788 million, a reduction in the scale of potential money capital by almost two-thirds, compared with the company's almost identical 2008 allocation. On the last day of trading in 2012 spot prices for EUAs were €6.53, well below the 2008 and 2009 forecasts, which similarly reflects the poor performance of carbon as an asset (European Energy Exchange, 2012).

The failures of carbon as an asset are most clear in the reluctance of financial institutions to accept carbon instruments as collateral for trading margins or lines of credit. Following the formulation of Leyshon and Thrift, collateralisation is a form of capitalisation that intensifies the accumulation of capital by leveraging the value of, or income streams from, carbon instruments to access much greater quantities of (fictitious) capital, rather than simply unlocking existing value, as with monetisation. Problems of collateralisation have been linked to the risks of fraud and uncertainty over the legal status of carbon allowances and credits (Padis, 2011). These legal issues are significant but resolvable in technical terms. More fundamental is the political economic question of the reliability of the rents that form the underlying value of carbon assets.

Collateral for trading margins is required by parties entering into contracts for financial derivatives, set at a portion of the nominal values of contracts. In order to trade in futures and options, ICE, which hosts the European Climate Exchange, requires margins that can cover the cost of unwinding positions, to protect against the risk of default (Intercontinental Exchange, 2015a). If traders can meet this requirement, they can enter into contracts for derivatives in carbon and other commodities, interest rates and currencies with notional values worth many times the value of the margin. ICE accepts various financial instruments as collateral for margin, including those linked to government bonds, currencies, and previously, emissions allowances. The margin value is calculated by the 'haircut' applied by ICE, reflecting the risk of the collateral. Bonds issued by the US government, for example, are among the instruments given the smallest haircut of 3 per cent, because they are the most secure (Intercontinental Exchange, 2011).

From September 2009, ICE accepted EUAs as collateral for up to 30 per cent of margin requirements and CERs as collateral for up to 5 per cent of margin requirements, with a 25 per cent haircut on each of their values (Intercontinental Exchange, 2009). The much greater haircut than that applied to US government bonds, and the limits on their total use in meeting total margin requirements, reflected judgements made about the relatively higher risk of carbon allowances, and especially carbon credits, compared with other forms of collateral. Nevertheless, acceptance as collateral indicated some willingness to leverage the value of carbon. However, between February and June 2011 ICE gradually increased the haircut to 100 per cent (Point Carbon, 2011). This made carbon completely worthless as collateral in the exchange, and keeping carbon in margin accounts would simply incur handling fees for no benefit. Leveraged positions on carbon contracts could still be taken. The ArcelorMittal (2010a: 49) example is evidence of this, as the notional values of their derivatives of US$171 and US$162 million in 2008 and 2009 outlined above had a market value of only US$32 and US$47 million. But under the new ICE rules carbon assets themselves could not be capitalised to achieve this leveraged position.

The initial decision by ICE was triggered by the risks associated with stolen carbon credits but, as of April 2015, the 100 per cent haircut remained in place (Intercontinental Exchange, 2015c). This is despite the adoption of enhanced security arrangements, such as shifting from the national registries that were targeted to a central European registry and the publication of a list by ICE of the serial numbers of stolen allowances to ensure they are not traded in the exchange (Intercontinental Exchange, 2015b). This enhanced legal security has been undermined by diminished economic security. On 1 June 2011, when the 100 per cent haircut was instituted, EUA and CER futures for delivery in December 2014 were trading at €19.98 and €14.15, respectively. Since then, the same contracts have fallen as low as €2.88 for EUAs and €0.02 for CERs (Intercontinental Exchange, 2014).

Collateral is also needed for access to more traditional types of credit such as securing a loan. Like exchanges, lenders require collateral that can be seized in the event of a default on loan repayments. Borrowers use collateral to secure more favourable terms in the form of lower interest charges and/or to increase the size of the loan. Carbon is therefore capitalised if the value of future allowance allocations or future issued offsets leverages credit to support and expanded rate and/or scale of accumulation than would otherwise be possible.

Neither future allowances allocations nor expected credit issuances have been readily accepted as collateral for lines of credit (Cox et al., 2010: 32–3; Ellerman et al., 2010: 322). In fact, rather than leveraging the value of carbon commodities, it has been difficult to even bring forward the simple monetary value of carbon credits from offset projects for which ERPAs exist (World Bank, 2010: 44–5). Examples of the collateralisation of such contracts are heavily concentrated in arrangements involving state authorities acting in an international development capacity. In 2010, a loan was granted by Spanish bank Banco Santander to the project developer of two wind farm CDM projects in Mexico using the ERPA as collateral. Banco Santander judged the income streams from the sale of carbon offsets as sufficient to repay the loan. Those income streams were underwritten by the German government's development bank KfW and the Nordic Environment Finance Corporation, another development bank jointly owned by the governments of Denmark, Finland, Iceland, Norway and Sweden, with which the ERPA was made (NEFCO, 2010). The concessional nature of the arrangement mitigated the risk that Banco Santander could be exposed to price and delivery risks.

Without concessional arrangements, the income streams from many other ERPAs have not been guaranteed, which has made them risky collateral. Aside from the risks of non-delivery discussed previously, following the price crashes, buyers have used everything from loopholes in contracts (such as protections against non-delivery), to collusion with project verifiers, in order to renegotiate the terms of original contracts made with project developers, which would have otherwise locked them in to buy CERs for multiple times their eventual market price (Szabo, 2012). This has seen the terms of ERPAs change to reduce the volume of CERs contracted, shift from a fixed to floating price and use options rather than forwards (World Bank, 2012: 50–1). All of these moves reduce the overall value of ERPAs and the prospects for their collateralisation.

The capitalisation of carbon has therefore faced significant challenges with respect to collateralisation because carbon commodities have not been easily leveraged to gain access to traditional forms of interest-bearing capital that borrow from the future to expand accumulation. Problems of collateralisation cast further doubts on the additionality of offset projects because it reduces the advantages of CDM project status compared with business as usual. This not only has implications for the climate, but also the carbon market accumulation strategy, because it means carbon credits from the CDM and JI are unlikely to engender additional surplus value production at projects that would otherwise not occur, and instead dissipate carbon rents circulating in carbon allowances, worsening the crisis in the EU ETS. Overall, windfall profits from expropriation, and new economic activity from the extension of financial relations, have not been supported by the intensive capitalisation of carbon, through monetisation or collateralisation, which Fine, and Leyshon and Thrift, argue is necessary if financial markets are to support the expanded reproduction of capitalism.

Conclusion

In 2009, just three years after announcing the arrival of carbon as capital, the same banker was describing the EU ETS as “practically a joke.” The next year he reported that Fortis’ commodities desk had shifted away from carbon and towards oil and agricultural commodity trading, explaining that “I don't see there is a proper business to be had in carbon” (Chestney, 2009a, 2010). The disillusionment conveyed in these sentiments and actions are symptoms of the breakdown of the carbon market accumulation strategy. This chapter has demonstrated that the expropriation emphasised by Bohm et al. and Lohmann, and the new financial activity emphasised by Newell and Paterson, in their carbon markets as new sites of accumulation theses, have indeed occurred, albeit in diminishing ways. But the sustainability of the carbon market accumulation strategy has to be regarded as contingent and dependent on the successful capitalisation of carbon – an intensive form of accumulation – which has only occurred occasionally rather than systemically due to the unreliable nature of carbon rents. Thus, the breakdown of accumulation within carbon markets is due to a failure in the emergence of – following Martin O'Connor's (1994b: 126) notion of a "system of capitalised nature" – a system of capitalised carbon.

Although the intention of states in instituting carbon markets may have been to advance the accumulation of capital, in practice states have been unwilling and/or unable to support its realisation through commodification practices that ensure the circulation of carbon rents in carbon allowances and credits. In their "accumulation by decarbonisation" thesis, Bumpus and Liverman (2008) discuss the ability of carbon markets to support accumulation in new industries and protect fossil fuel industries from direct threats to accumulation. However, states face a paradox where at certain points, securing the carbon rents required to capitalise carbon in new industries raises costs of production in ways that become barriers to the appropriation of carbon by polluting corporations, which is the underlying source of value in carbon markets. The disjuncture between the intention and practice of state policy can be understood as a manifestation of the contradiction between appropriating and capitalising nature proposed by Moore and discussed in the first section of this chapter.

The question then becomes: could the contradiction between "accumulation by appropriation" and "accumulation by capitalisation" be addressed, as Moore (2014a: 28) suggests, in ways that see the capitalisation of carbon combine with, rather than act as a barrier to, the appropriation of carbon? Marx's analysis of both the obstructive and disciplinary dimensions of rents suggests that it could. Marx (1991: 959) recognises the obstructive aspect of rents in arguing that "appropriation and distribution of surplus-value or surplus product by capital, however, meets with a barrier in landed property." But Marx (1991: 960) then goes on to say that in expropriating rents:

> The landowner does play his role in the capitalist production process, not only by the pressure that he exerts on capital and not simply by the fact that large

> landed property is a premise and condition of capitalist production, but particularly by the way he appears as the personification of one of the most essential conditions of production.

Acknowledging the pressure exerted on capitalist production by rents on natural conditions moves beyond Felli's insistence that carbon markets simply drain surplus value. It instead raises the possibility if the more valuable and reliable carbon commodities needed to capitalise carbon came into fruition, carbon markets could increase the surplus value produced through the appropriation of carbon by playing the disciplinary role of Marx's landholder.

Indeed, there are signs of the emergence of the logic of derivatives discussed by Bryan and Rafferty (2013: 136–7) in which capital and labour are disciplined through the relentless comparison of the performance of different bits of capital, in carbon markets. This can be seen in the range of calculative tools developed in response to the EU ETS to compare the performance of different carbon-intensive production processes. For example, electricity generators in Europe shifted from the 'dark spread' and 'spark spread' metric, which calculates and compares the profitability of coal and gas-fired electricity production with reference to power and fuel prices, to the 'clean dark spread' and 'clean spark spread', which also incorporates carbon prices (World Bank, 2012: 34n). Similar calculations and comparisons appear in ArcelorMittal's annual reports where carbon derivatives are accounted for in conjunction with iron ore, energy, freight, interest and exchange rate derivatives (ArcelorMittal, 2010a: 43). The European Climate Exchange standardises these hedging practices by offering margin offsetting between carbon and oil, gas, coal and power derivatives that reduce collateral requirements for instruments in cases where price movements tend to cancel each other out (Intercontinental Exchange, 2015c). Investment banks UBS and Barclays also each created indexes combining movements in carbon and weather derivatives, the latter being significant for both the profitability of electricity production and the material impacts of climate change (Cooper, 2010; Davies, 2008). All of these developments function to discipline the production of surplus value from the appropriation of carbon but have been undermined by the collapse of carbon rents.

Imperatives to intensify the appropriation of carbon are built into the structure of the EU ETS. Regulating emissions at the installation level encourages scrutiny of the appropriation of carbon by individual factories, power plants and other production units within and between the boundaries of different corporations. Because carbon commodities are not attached to any particular production process, but simply allow installations regulated by the EU ETS to emit something, somehow, somewhere at some time, they can exert general pressure on all carbon-intensive production processes. The emissions cap, if sufficiently stringent, then enforces trade-offs between the profitability of different forms of carbon appropriation. Within the cap, the extent to which the cost of carbon rents obstruct particular carbon-intensive production processes opens up the appropriation of an equal 'bit' of carbon in another production process that produces more surplus value. In this way the intensive capitalisation of carbon allowances may become the basis of a sustainable accumulation strategy through its successful combination with the intensive appropriation of carbon. Because the intensive appropriation of carbon is measured by increases in surplus value rather than the material combustion of fossil fuels, such a strategy can be consistent with reductions in emissions as some existing carbon-intensive production process are unable to withstand the discipline of carbon markets. Yet, by entrenching the most profitable forms of carbon appropriation in the process, such emissions reductions are achieved in a manner that makes future emissions reductions increasingly difficult; this is the 'least cost' rationale of carbon markets laid bare.

James O'Connor (1998: 162) sees state policies aimed at exerting greater control over the uncontrolled production of nature as a "socialisation" of the conditions of production that could, subject to political contestation, represent a movement towards a post-capitalist future. The argument is constructed to parallel arguments on the socialisation of production by the corporate form, which Marx (1991: 567) famously described as "the abolition of capital as private property within the confines of the capitalist mode of production itself." But just as Chapter Three argued that the combination of the corporation and fossil fuels reorganised production on capital's own terms, unencumbered by particular owners and local environments, the socialisation represented by carbon markets could more completely subsume the appropriation of carbon to the logic of capital, unencumbered by particular carbon-intensive corporations or production processes. Carbon markets therefore threaten to sharpen, rather than challenge, the intentional structure of capitalist production, which Chapter Two argued, drawing on Benton, underpins the production of climate change. It is in this sense that carbon markets may indeed become "part of larger process by which the production of nature is being dramatically intensified and its dimensions multiplied" (Smith, 2006: 24).

A viable carbon market accumulation strategy has, however, thus far remained elusive as a result of the failure of states to adequately support the circulation of value in carbon commodities. Political economic assessments of the EU ETS and the Kyoto mechanisms must take account of the current crisis of accumulation in carbon markets, which shapes the efficacy of policies in different ways to that which has been argued in the critical literature. In the next and final chapter of this thesis, the crisis of carbon markets is the backdrop for analysis of the political struggles over three proposals to reform the EU ETS. The prospects for climate action inside and outside the market-based paradigm depend on such struggles, which are discussed in terms of their implications for the circulation of value.

7 – The politics of carbon market design

Introduction

The economic problems that have engulfed the European carbon market have provided the impetus for a series of proposals to reform the EU ETS. A focus on political contestation over these proposals is important for evaluating the central research question of the thesis on the efficacy of carbon markets in addressing climate change for two reasons. The first regards the potential to overcome the shortcomings of EU ETS identified in this thesis. The second is to understand the broader effects of the institutionalisation of the market-based approach on the prospects for climate action more generally. Building on the previous chapter's analysis, this chapter asks how the marketisation of climate policy, in the context of the crisis of carbon markets, has shaped the politics of climate change in the EU. The question is explored across three episodes in the ongoing debates to reform the EU ETS: qualitative restrictions on industrial gas offsets, backloading of allowance auctions and the 2030 climate and energy package.

As flagged in the Introduction, post-structuralist perspectives, including actor-network, performativity and governmentality approaches, have provided fertile ground for analyses of the politics of carbon markets (Lövbrand and Stripple, 2011; Lovell and Liverman, 2010). Callon's take on the politics of carbon markets concentrates on their experimental nature. Carbon markets are described by Callon (2009: 535) as "between *in vitro* and *in vivo* experiments." This aims to capture the interplay between the designing of carbon markets in the laboratory of economic theory (*in vitro*) and the ongoing redesign and rearrangement of carbon markets in practice (*in vivo*) by those involved in, or concerned with, their functioning. The implication of thinking about carbon markets in this way is that policy outcomes are contingent on the design of the experiment, thus providing opportunities for a "politics of market design" focused on influencing carbon market experiments (MacKenzie, 2009: 440). The most extensive treatment of this project, which Callon describes as one of (2009: 547) "civilising markets," comes from MacKenzie (2008: 175–6) who characterises the political terrain of carbon markets as "technopolitics." This is because it is located not just in the formal political processes of representative democracy, but also in "subpolitical" realms, such as scientific and accounting bodies, where seemingly technical decisions are made that substantively shape the operation of carbon markets (MacKenzie, 2009: 453).

MacKenzie cites the experience of the US sulphur dioxide trading scheme, outlined as part of the short history of carbon markets in the Introduction, as an exemplar of the capacity of the technopolitics of market design to generate positive outcomes. Like the EU ETS, when the US scheme began in 1995 it had an overly generous emissions cap and allocation rules that saw emissions allowances largely distributed to polluters for free. This, according to MacKenzie (2008: 145–6), was necessary to gain sufficient political acceptance of the scheme by industry and politicians. But within the negotiating process, actors with the goal of achieving greater stringency successfully inserted a so-called 'ratchet' clause that would introduce a tighter absolute cap on allocations from the second phase of the scheme, beginning in 2000. Following the legislation of the scheme and the end of the formal political process, bureaucrats at the Environmental Protection Agency tasked with implementing what had been negotiated used the ratchet to cancel out the initial concessions for polluters by scaling back allowance allocations by 10 per cent (MacKenzie, 2008: 147–8). Mackenzie interpreted some early EU ETS reforms, including the change to the formula used by the European Commission in approving governments' phase two National Allocation Plans (NAPs), as potentially containing the European scheme's equivalent of the sulphur dioxide ratchet. Although the Introduction noted that the change was unable to address the over-allocation problem, the example is significant because it is used to justify the politics of market design. This politics, MacKenzie (2008: 176) argues, "focuses not just on the overall virtues and demerits of market solutions but on technopolitical specifics such as the ratchet and NAP formula. The need for such a politics is large."

The type of politics promoted by MacKenzie and Callon is given a less charitable treatment by Swyngedouw. A politics focusing on the details of carbon trading is indicative of what Swyngedouw (2010: 225) characterises as the "de-politicisation" of climate change as part of a general shift towards a "post-political" society and "post-democratic" governing. In contrast to the "proper democratic political," Swyngedouw

(2010: 225) argues that post-politics is "marked by the predominance of a managerial logic in all aspects of life, the reduction of the political to administration where decision-making is increasingly considered to be a question of expert knowledge and not of political position." Rather than representing an expanded conception of politics that brings new possibilities, the reduction of politics to questions of "administrative and techno-organisational means" narrows the field of potential political pathways because it "forecloses (or at least attempts to do so) politicisation and evacuates dissent" (Swyngedouw, 2010: 225–7).

For Swyngedouw (2010: 220), the fetishism of the carbon commodity is an emblem of the depoliticisation of climate change. Indeed, drawing partly on an earlier iteration of Swyngedouw's (2005b) thesis, Bailey and Wilson (2009: 2325) argue that the carbon market paradigm "exhibits a strong privileging of neoliberal and technocentric values that creates serious obstacles for the contemplation of alternatives, particularly more ecocentric ways of curbing greenhouse-gas emissions." As with Swyngedouw, they link the institutionalisation of such technocratic values with path dependency effects that result in a "narrowing and hardening of the 'boundaries of the possible'" (Bailey and Wilson, 2009: 2338). The argument finds empirical support in Toke's (2008) study of the privileging of emissions and renewables trading schemes over alternative regulatory options in the UK.

The post-political frame is not without its detractors either. While acknowledging the validity of many of the arguments advanced using the concept, McCarthy (2013: 20–4) questions whether the project is a new phenomenon and how hegemonic it is in different parts of the world. The argument is illustrated with historical examples of (failed) attempts to institute depoliticised modes of environmental governance and reference to both the continued politicisation of climate science by conservative forces – acceptance of which forms a critical plank of any post-politics of climate change – and the emergence of progressive grassroots and direct action climate movements operating outside established structures. Lastly, McCarthy (2013: 24–5) warns against the counter-posing of the post-political with 'proper' politics because it represents a too constrained understanding of the diversity and logic of political action.

Some of these themes have been developed to consider the relationship between carbon markets and policy outcomes inside and outside the market framework, and the character of political contestation involved, mostly relating to the CDM. Though operating within the same performativity frame, Blok (2011: 457) criticises MacKenzie's focus on "attitudes" taken towards carbon markets. Instead, notions of consumption, engagement and confrontation are offered as a typology of political practices adopted by NGOs in relation to the CDM (Blok, 2011: 453). Newell touches on post-political themes in analysing the CDM Policy Dialogue, an initiative designed to review and make recommendations to reform the CDM. The process is described as a form of "disciplinary neoliberal participation" where "participation in invited spaces takes the form of discussion around a pre-proscribed set of themes where the range of possible outcomes is delimited to ones acceptable to those organising the process" (Newell, 2014a: 215). While understanding the CDM Policy Dialogue as a way of depoliticising debates over carbon markets, Newell (2014a: 231–2) also emphasises the role of campaigns from environmental organisations that undermined the legitimacy of the CDM in bringing on the process, and that of powerful actors with political economic interests in maintaining the CDM in structuring it. The outcome of the CDM Dialogue, a series of recommendations designed to consolidate the CDM by boosting carbon prices (Newell, 2014a: 231), reflects Paterson's (2009) argument that resistance to carbon markets becomes incorporated into projects to restore their legitimacy, though often not in the manner envisaged by climate activists. Indeed, the successful linking of the project of CDM reform to "the fate of the climate itself" (Newell, 2014a: 227) speaks to Paterson and Stripple's (2012: 565) contention, employing a Foucauldian governmentality approach, that the link between carbon markets and climate change serves to "neutralise" resistance.

The present chapter builds on this work on political practices, power dynamics and market logics in contestation over carbon markets by extending the analysis on questions of value and the capitalisation of carbon developed in the previous chapter. The chapter proceeds from the contention, put forward in the conclusion to Chapter Six, that the fundamental structure of the EU ETS contains the potential to intensify the role of capitalist value relations in organising the appropriation of carbon. The reform proposals are integrally related to the realisation of this potential because they concern the role of the state in supporting the circulation of value through carbon commodities. The state as an institutional force is largely excavated from the accounts of MacKenzie and Callon, while Swyngedouw (2010: 227) focuses on the transformation from state "government" to forms of "governance" shared between state and non-state actors. In this chapter, the conception of the state follows O'Connor by focusing on its structural position in regulating capital's access to, and use of, natural conditions in seeking to assert control over the uncontrolled production of nature. O'Connor (1998: 152) stresses that this function of states is complicated because "the capitalist state is a bureaucratic state within a formally democratic political system." The capitalist character of the state impels it to produce conditions of production that support the accumulation of capital. However, its bureaucratic organisation, comprising multiple apparatuses with their own objectives and particular constituencies, and the competing interests in the conditions of production (and life) from different configurations of capital and social movements, means "the provision or regulation of the conditions of production is a highly contradictory process" (O'Connor, 1998: 150).

Robertson and Wainwright consider the contradictory position of states attempting to assert control over natural conditions in explicitly value terms. Echoing O'Connor, they argue "capitalist states must facilitate the measure of new values because they are necessarily involved in the regulation of capitalism's transformation of the natural environment" (Robertson and Wainwright, 2013: 900). The context of the study is debates over the definition of value – whether market price, individual utility or ecosystem functions – in the regulation of wetlands banking schemes in the US. Different agencies of the US state had competing positions on this question, with some favouring market devolution and others wishing to maintain decision-making based on scientific principles. The contest is interpreted in terms of the need for states to both create new opportunities for accumulation and maintain its own capacity to regulate the conditions of production for the reproduction of capitalist social relations generally. Robertson and Wainwright (2013: 899) conclude that the state must "thread a relatively fine needle: to ensure that the capitalist value form expands but prevent it from becoming the sole means of determining the identification of objects and the measurement of their qualities."

Following O'Connor's and Robertson and Wainwright's formulations, this chapter understands debates over the three proposals to reform the EU ETS as contests over the extent to which states assert control over the production of climate change by intensifying capitalist value relations using carbon markets. The three reform debates represent three dimensions of the issue. Respectively, qualitative restrictions on industrial gas offsets, backloading of allowance auctions and the 2030 climate and energy package concern the reach, force and priority of value relations in regulating the appropriation of carbon. Of course, all parts of the economy are subject to existing capitalist value relations to a greater or lesser degree. The focus is on the specific impact of carbon markets on intensifying value relations by more sharply subjecting the appropriation of carbon to the discipline of capitalist profitability. The cases selected represent major post-recession debates over three key aspects of the European carbon market: the link between the EU ETS and the CDM, the EU ETS surplus, and the interaction between the EU ETS and other policies. They are presented in chronological order, focusing on the way different institutions of the EU and its member states, the largest polluting industries and other corporations with economic interests, and mainstream environmental organisations, engaged with the formal policy making process.

The reach of value: Industrial gas offset restrictions

The relationship between the EU ETS and CDM was the subject of contestation in debates over the eligibility of industrial gas offset credits. At stake was the reach of capitalist value relations, as intensified by carbon markets, in determining what project-emissions reduction relationships could be substituted for installation-emissions relationships in the EU ETS. Part Two of the thesis outlined the role of the CDM in securing political support for a European carbon market by weakening the constraints imposed by the EU ETS emissions cap. In MacKenzie's (2008: 145–7) terms, the CDM is a potentially archetypal political concession necessary to institute carbon trading that, though reducing its efficacy in the short term, was ripe for a politics aimed at clawing back those concessions once the scheme was in place. This was indeed the strategy adopted by many environmental organisations that campaigned for a ban on offsets from industrial gas destruction projects.

Opposition to the use of credits produced by destroying industrial gases, especially HFC-23 and N_2O from the production of adipic acid (as distinct from nitric acid production), was a broadly supported view in various segments of the environment movement. Opponents of these credits included mainstream environmental NGOs such as WWF and Friends of the Earth, carbon trading-focused groups CDM Watch (now Carbon Market Watch), Carbon Trade Watch and Sandbag, smaller social and environmental justice organisations including the Corner House, the Transnational Institute and FERN, as well as activists in India and elsewhere in the South (Böhm and Dabhi, 2009; Bond and Dada, 2007; Bullock et al., 2009; Environmental Investigation Agency and CDM Watch, 2010; Ghosh and Sahu, 2011; Gilbertson and Reyes, 2009; Kill et al., 2010; Lohmann, 2006; Öko-Institut, 2007). Some, such as Carbon Trade Watch and Friends of the Earth, used the issue of industrial gas offsets as part of a broader campaign to oppose carbon offsets or carbon markets in general (Bullock et al., 2009; Gilbertson and Reyes, 2009). Others, such as CDM Watch and WWF, campaigned to ban industrial gas offsets to improve the overall effectiveness of carbon trading (Environmental Investigation Agency and CDM Watch, 2010; Öko-Institut, 2007).

The sheer dominance of industrial gas credits in the offset market and the skewed distribution of projects towards India and China over smaller or less developed countries made them a useful target for campaigners. When the European Commission raised the possibility of qualitative restrictions in August 2010, just 19 HFC-23 destruction projects, representing 0.8 per cent of all registered CDM projects, had been issued an astounding 52 per cent of CERs. Similarly, four N_2O destruction projects from adipic acid represented 0.2 per cent of all registered CDM projects but accounted for 19 per cent of all issued CERs (Fenhann, 2010). CDM Watch effectively exposed the questionable environmental integrity that underpinned these numbers on the CDM's own additionality terms. Commissioned reports from private consultants demonstrated that many of the emissions reductions from HFC-23 projects were non-additional because the UN methodology used to calculate credit issuance encouraged increases in HCFC-22 production entirely for the purposes of destroying HFC-23 in order to earn offset credits (Environmental Investigation Agency and CDM Watch, 2010; Schneider, 2011). Similarly, many credits produced from destroying N_2O were also found to be non-additional because the relevant methodology had encouraged a shift in adipic acid production away from non-CDM plants that were voluntarily abating N_2O to CDM plants that could earn credits (Schneider et al., 2010). Industrial gas projects were also criticised for diverting CDM investment away from renewable energy projects due to the low upfront costs per tonne of CO_2-e reduced (Environmental Investigation Agency and CDM Watch, 2010). These arguments were supported by broader critiques on the negative social and environmental outcomes of industrial gas CDM projects (Dabhi, 2009). Campaigns against HFC-23 projects in particular also attracted some high-profile mainstream media attention (e.g. Bradsher, 2006; Ghouri, 2009; Klawitter, 2010).

Commissioner for Climate Action, Connie Hedegaard, explicitly framed the Commission's intent to develop a proposal to ban the use of industrial gas offsets as a response to the successful campaign of delegitimisation, stating "the CDM has been successful in some aspects but has also given rise to criticism, e.g. with regard to environmental integrity…The international debate has made it quite clear what changes to the CDM are needed" (European Commission, 2010d). The majority of state, industry and environmental actors engaged in the formal debate shared this concern that the continued use of industrial gas offsets posed a threat to the CDM as a whole. The key points of contestation were the timing of the impending ban and the potential for further qualitative restrictions on other project types.

Reflecting the position of the Commission, WWF argued that "the use of bad quality credits in the EU ETS is often used by opponents to the system as an argument against cap & trade in general and discredits this market-based instrument globally, making it harder to 'sell' it in other regions of the world" (WWF Europe, 2010). WWF's position went beyond questions of the legitimacy threat posed by industrial gas offsets, though, by pointing to the positive contribution that banning industrial gas offsets would make to the socio-ecological outcomes of carbon markets. It argued that a ban on offset credits from 1 January 2013, with no possibility of banking into phase three, was necessary to boost carbon prices, reduce the overall EU ETS surplus and favour investment in higher quality CDM projects. Further, the industrial gas offset ban was pitched as a step towards additional bans from other controversial project types including efficient coal-fired power stations and large hydroelectric dams (WWF Europe, 2010).

Corporate responses focused on delaying any ban for as long as possible and ensuring it was limited to the particular environmental additionality issues affecting industrial gas projects, not the broader social, political or economic goals suggested by environment groups. Enel and EDF, the two companies with the largest direct financial stakes in industrial gas projects, being project participants in eight and five such projects, respectively, were most concerned about the timing of the ban (Fenhann, 2014a, 2014b). EDF directly highlighted the financial impact of a phase three ban, arguing it had:

> Made firm commitments to credits issued in regards of reductions realised up to 31 December 2012. Such commitments have been made in good faith based on the shared understanding market participants had that such credits were free from regulatory eligibility risks. Restricting the eligibility of those credits in phase III would obliterate the value of those commitments triggering significant losses for ETS operators and investors (EDF Group, 2010).

BusinessEurope reflected the general concerns about expanding the basis for further qualitative restrictions in arguing that for any decision to ban industrial gas offsets "the criteria must be primarily based on the environmental integrity of the projects and shall not consider differences in abatement costs or host nation or be driven by concerns over the supply and demand balance" (BusinessEurope, 2010). The financial actors represented by the Carbon Markets and Investors Association (now known as the Climate Markets and Investors Association) were particularly concerned with the risks of further qualitative restrictions for the functioning of the market, stating:

> Using [qualitative restrictions] for e.g. political leverage, regulating the profitability of projects, controlling the price of carbon or other reasons than maintaining the integrity of the EU ETS, are, from a market perspective, regulatory measures, which will sap investors' confidence in the EU ETS, the

CDM and future climate change mechanisms (Carbon Markets and Investors Association, 2010).

The positions of capital are indicative of the contradictions faced by state institutions regulating the EU ETS. States attempting to foster value relations by extending the scope of abstraction in carbon commodities are faced with contradictory impulses arising from the politicisation that stems from their central role in the process. The politicisation of abstractions such as project types then threatens the functioning of the carbon market from the perspective of capital. This contradiction is clearly illustrated by Enel's representation on the issue, which oscillates between arguing for the maximum abstraction needed for the circulation of homogenous commodities, while also pragmatically acknowledging political limits. Enel stressed it was important that "all compliance instruments have the same value of one tonne" and warned that qualitative restrictions would "lead to market fragmentation, as different acceptance of CERs/ERUs under distinct jurisdictions will further undermine liquidity and require market participants to create differentiated contracts for trading CERs/ERUs" (Enel, 2010a, 2010b). While nevertheless acknowledging political concerns, Enel sought to limit reasons for qualitative restrictions to the economic logic of carbon markets, arguing "justified doubts over the environmental integrity of a project type should therefore be the only legitimate reason for excluding certain types of CER/ERU" in order to "maintain utmost confidence in the EU ETS as unbiased market mechanism" (Enel, 2010a).

At the conclusion of the consultation period on 25 November 2010, the Commission released its draft proposal for a full ban on offset credits produced by HFC-23 and N_2O from adipic acid projects from the earlier date of 1 January 2013. The preamble to the proposal stated the ban was necessary to address damage to "public confidence in market-based mechanisms," especially in light of inaction from the CDM Executive Board (European Commission, 2010a). The Commission also argued that the ban was needed to address the inequitable distribution of CER production between countries, the detrimental impact of the profitability of industrial gas projects on other renewable energy and energy efficiency projects and the disincentivisation of measures for reducing emissions from industrial gases at the national level and through the Montreal

Protocol (European Commission, 2010c: 6–16). Thus, the Commission's position went beyond additionality concerns and reflected broader arguments from environmental groups such as CDM Watch and WWF. It also reveals another state logic within the Commission's bureaucracy geared towards maintaining control over the scope of abstraction in order to achieve particular outcomes.

Following the release of the Commission's proposal, corporate actors, such as the International Emissions Trading Association, focused on having the date pushed back from 1 January 2013 to 1 May 2013 to extend the eligibility of industrial gas offsets to the entirety of phase two, the final surrender of which was 30 April 2013 (IETA, 2010). Freedom of information requests revealed intense lobbying of the Commission by Enel and BusinessEurope, and multiple companies, including Lafarge, Tata Steel, Total and RWE made similar representation to the UK government (Corporate Europe Observatory, 2011; Krukowska, 2010). The Chinese Government also published strong objections from affected CDM project operators (Department of Climate Change, National Development and Reform Commission, 2011). EU National states, which had to approve the Commission's Regulation through the EU Climate Change Committee, voted on 21 January 2011 in line with corporate demands to push the date back to 1 May 2013, led by the governments of Italy, the UK, Poland, and Germany (Chestney, 2011; European Commission, 2011b). The delayed ban opened the door for an estimated additional 30-40 million industrial gas credits to be surrendered, which was criticised by groups such as CDM Watch (CDM Watch, 2011; Krukowska, 2011). This significantly ameliorated the financial impact on companies such as Enel, which was able to surrender close to 17 million CERs for 2012 compared to fewer than 4 million for 2011, 99.5 per cent of which were from HFC-23 or N_2O adipic acid projects (European Commission, 2013b).

Despite the weakening of the proposal, the campaign against industrial gas offsets successfully achieved its goal of banning the use of the credits, which represented a significant proportion of the CDM market (Fenhann, 2014a). The evidence against the negative impacts of HFC-23 and N_2O projects made this an important decision in its own right. However, the broader goals of the campaign, including addressing the oversupply of offsets in the EU ETS market and achieving more qualitative offset restrictions, have not been realised. Throughout the debate on the proposal, the expectation among state and corporate actors was that the ban would have a relatively insignificant impact on the EU ETS as a whole. Analyses by the Commission, Point Carbon and Bloomberg New Energy Finance found that the supply of non-industrial gas credits would exceed the total EU ETS cap on offsets and therefore would not lead to an increase in carbon prices to the extent necessary to have an impact on investment patterns (Bloomberg New Energy Finance, 2010; European Commission, 2010c; Point Carbon, 2010a). The forecasts have proven to be accurate. Further qualitative restrictions on problematic project types have also not been forthcoming. The Commission actively sought to quell corporate concerns about this prospect by making it clear that it was not considering further project type restrictions (European Commission, 2010e). A ban on CERs from projects registered after 2013 that are not based in 'least developed countries' has, however, been implemented. But this doesn't affect existing CDM projects and won't reduce the total quantity of offsets available to EU ETS installations (European Commission, 2015a).

The force of value: Backloading allowance auctions

Debates in 2012-13 over temporarily withholding the auctioning of allowances scheduled for the beginning of phase three, and reintroducing those allowances through larger auctions at the end of the phase, were more explicitly contests over increasing carbon prices. 'Backloading' was therefore fundamentally concerned with managing the force of value relations, as intensified by carbon markets, in organising the appropriation of carbon. The Commission argued the intervention was necessary not only due to the 1 billion surplus allowances that had already accumulated by 2011, but also because of a specific set of circumstances that was projected to result in a rapid increase in the surplus to 1.5-2 billion by 2013, placing more downward pressure on prices (European Commission, 2012b: 10–11). Although backloading would not affect the overall quantity of allowances auctioned in phase three, the Commission expected the measure would boost carbon prices in the short-term and buy time for more permanent reform (European Commission, 2012b: 12–15). The Commission proposed to implement backloading by amending the EU ETS' Auctioning Regulation. However, there were questions over whether this path was legally justified, so the Commission also decided to propose an amendment to the EU ETS Directive to achieve "full legal certainty" over its powers (European Commission, 2012b: 5). Unlike amending a Regulation, amending a Directive requires a full decision-making procedure involving the Parliament and Council, which triggered a protracted debate between the Commission, members of European Parliament, ministers of member states, industry groups and environmental organisations.

A number of environmental organisations once again actively engaged in political debates over backloading to support a strong proposal that could also lead to further reform. Sandbag, a British research and campaigning organisation focused on carbon markets, played a similar role to that of CDM Watch in the industrial gas debate. Sandbag published a series of widely-distributed reports calculating the accumulating allowance surplus in the EU ETS and highlighting the legacy it would cause in cancelling out future emissions reductions (e.g. Morris, 2011, 2012). WWF and Greenpeace also adopted a strategy of engaging with the technical details of the surplus problem, and promoting the backloading solution, by appointing a private consultancy to assess the causes and size of the surplus and offer options for reform (Hermann and Matthes, 2012). WWF, Greenpeace and umbrella organisation CAN Europe demanded a backloading of 1.4 billion allowances, equal to their report's projected 2020 surplus. They also saw backloading as a step towards further reform of the scheme, which they affirmed their support for, through a permanent cancellation of 2.2 billion allowances as part of a plan to increase the 2020 emissions target from 20 to 30 per cent (Climate Action Network Europe, 2012; Greenpeace Europe, 2012; WWF Europe, 2012). Later, WWF, Greenpeace and CAN Europe staged a protest stunt outside the Parliament, holding a mock carbon auction to highlight the low price of allowances and urging members of Parliament to find the "right price" (Climate Action Network Europe, 2013). A key exception was Friends of the Earth, which avoided engagement with the formal political process over backloading. Friends of the Earth took a relatively hostile position to the proposal, as part of a general sceptical position on the scheme as a whole, arguing "no amount of fiddling with the ETS will make the system fit for the challenge of tackling the climate crisis" (Friends of the Earth Europe, 2013a).

A general split emerged between polluting industries on the backloading proposal, with the electricity sector in support and carbon-intensive manufacturing, including the iron and steel, cement and chemical industries, in opposition. For the electricity industry, the backloading measure was necessary to save the EU ETS and fend off the adoption of alternative policies at the national level. In their submission in support of the proposal, EURELECTRC, which represents electricity companies at the European level, stated that the "ETS today is at risk of being undermined and replaced by other policy instruments" (EURELECTRIC, 2012). Similarly, GDF Suez warned "the credibility of the EU ETS is now at stake with a carbon price so low that it does not represent a valuable price signal" and called for a permanent rather than temporary withdrawal of allowances (GDF Suez, 2012). Concerns about the credibility of the EU ETS were extended by the Climate Markets and Investment Association, which sided with the electricity industry in supporting backloading, to the implications for the spread of carbon markets globally (Climate Markets and Investment Association, 2012). Within the general supportive position of the electricity industry, there were geographical differences, with Polish companies such as Tauron dissenting from EURELECTRIC's position on the basis that the company opposed any move that would increase costs (Tauron Polska Energia, 2012). This was also the primary reason manufacturers, organised under the umbrella of the Alliance of Energy Intensive Industries, opposed backloading. The group argued against any "artificial cost increase" on the basis that it would reduce the international competitiveness of European industry (Alliance of Energy Intensive Industries, 2012).

The split between electricity and gas and manufacturing saw BusinessEurope, the umbrella organisation for national business organisations from all industries, "on balance" oppose the measure (BusinessEurope, 2012). While reiterating its support for the EU ETS, its reasoning focused on the "uncertainty" created by state intervention in the market. This concern was held by corporate actors that were both supportive of and opposed to backloading and related to the Commission's proposed amendment to the EU ETS Directive to ensure the legality of the backloading regulation. The specific proposal to amend Article 10 of the Directive, which governs auctions, was that "the Commission shall, where appropriate, adapt the timetable for each period so as to ensure an orderly functioning of the market" (European Commission, 2012c).

Protestations of uncertainty stemmed from whether the proposed amendment would lead to ongoing discretionary state intervention beyond backloading.

Responses from both the Alliance of Energy Intensive Industries and E.ON to the proposed amendment illustrate corporate ambivalence about the role of the state in the carbon market. E.ON supported backloading because it recognised that some form of state intervention was necessary to secure the operation of the market, arguing that the measure would "be regarded as a positive sign of policy-makers' commitment to the ETS. In a politically-grounded market such as the EU ETS, this is crucially important since it allows market participants to take a long-term view." However, E.ON also opposed the Commission's proposed amendment to the Directive because it viewed ongoing intervention as a threat to that goal, arguing "frequent market interventions to mitigate the effect of preceding interventions would destroy the trust of market participants in the 'orderly functioning' of the market" (E.ON, 2012). The Alliance of Energy Intensive Industries articulated this concern more explictly. In addition to their objections to increased costs, the industry group argued "the proposal puts an end to the notion of the ETS as a market-based instrument. Trying to manipulate carbon prices through political intervention will now require a risk calculation based on the likelihood of further political intervention" (Alliance of Energy Intensive Industries, 2012).

The contributions of E.ON and energy-intensive industry comments are indicative of another contradiction facing states in carbon markets, this time in relation to supporting accumulation rather than gaining legitimacy. Value cannot circulate through carbon commodities without state regulation. As argued in the previous chapter, states have not supported the circulation of value as carbon rent to a sufficient-enough extent to create a system of capitalised carbon. The crux of the backloading debate was whether and how states should boost the scale of carbon rents captured within EUAs. The contradiction arises because state measures to support carbon prices, such as backloading, are necessary to support the capitalisation of carbon. However, such measures simultaneously undermine the calculative practices through which capital can profitably participate in carbon markets.

Following the consultation process, the Commission made a more detailed backloading regulation proposal specifying that the auctioning of 900 million allowances would be withheld between 2013 and 2015, and instead auctioned in 2019 and 2020 (European Commission, 2012a). The majority of national states supported the proposal. Poland and Germany were notable exceptions. Poland was strongly opposed to any change because it feared the proposal would reduce auction revenue and hurt growth in its brown coal-dependent economy (Nelson, 2012). Officially, the German government was undecided. This was partly due to a split between the supportive Environment Minister from the main governing party (Christian Democratic Union) and the oppositional Economy Minister from the junior coalition partner (Free Democratic Party) (ENDS Europe, 2012). But as discussed in the Introduction, there was also significant opposition within the main governing party. Indeed, German Chancellor Angela Merkel, of the Christian Democratic Union, publicly raised concerns about the impact of backloading on energy-intensive industry (Nicola and Krukowska, 2013).

The debate in the Parliament was heavily focused on the question of whether the proposed amendment to the Directive would lead to ongoing intervention in the market. In general, more progressive MEPs, including those in the centre-Left Socialists and Democrats grouping, as well as the Greens, supported the proposal. More conservative MEPs, such as those in the centre-Right European People's Party and the European Conservatives and Reformists, opposed the measure (ENDS Europe, 2013a). The Parliament's conservative dominated Industry Committee sided with energy-intensive manufacturers and voted to reject the proposal outright. The progressive majority in the Environment Committee supported the proposal but, reflecting the concerns of industry, brought forward a series of amendments to ensure that the intervention would be a one-off (Committee on the Environment, Public Health and Food Safety, 2013). On 16 April 2013, following a parliamentary debate where supporters focused on the need to save the EU ETS and opponents argued it went against the market principles of the scheme, the backloading proposal was voted down 334 to 315, with 63 abstentions (European Parliament, 2013b, 2013d). The price of carbon allowances dropped 43 per cent to €2.63 with news of the result (Garside et al., 2013).

Following the negative vote, states in favour of the proposal pushed to have it revisited. Environment ministers from the United Kingdom, France, the Netherlands, Sweden, Germany, Denmark, Portugal, Finland and Slovenia formed the 'Green Growth Group' which called on the proposal to be agreed upon by July (ENDS Europe, 2013b). Indeed, on 3 July 2013, the Parliament supported the Commission's proposal 344 votes to 311, with 46 abstentions. The key legislative difference between the negative and positive votes was that in the latter, amendments were introduced restricting the potential for the Commission to intervene in the future (European Parliament, 2013a). Under the amended version that was supported, backloading could only occur if it would not disadvantage any sector, the conditions for intervention were changed from "shall, where appropriate" to "may, in exceptional circumstances" and 900 tonnes was set as the maximum total level of backloading (European Parliament, 2013c). Prices rose 12 per cent to €4.82 immediately following the vote (Clark, 2013). Member states gave their approval relatively quickly to the amended Directive and the new Regulation, with the Council and EU Climate Change Committee each giving their respective support in December 2013 and January 2014. The new German coalition government between the Christian Democratic Union and the Social Democratic Party that was formed after the federal election in September 2013 saw Germany vote in support of backloading, with only Poland remaining opposed (Council of the European Union, 2013; European Commission, 2014h; Flynn, 2013).

Like the industrial gas offset debate, the substantive impact of backloading was expected to be minimal and that is the outcome that has been realised. The Commission's impact assessment put the backloading proposal into perspective by calculating that even a permanent withdrawal of 1.4 billion permits, a far cry from the smaller, temporary measure on the table, would not increase carbon prices to above €30 in 2020 – less than the 2006 and 2008 highs (European Commission, 2012b: 16). Also like the industrial gas offset debate, the final decision was weakened over the course of the formal political process, which delayed the beginning of backloading until 2014, reducing the measure's ability to prevent the rapid surplus allowance build up at the beginning of phase three. The upward pressure on carbon prices has indeed been negligible. The extensive contestation over backloading measure can therefore be better understood as a debate over the broader role of the Commission in regulating the

European carbon market. The outcome – agreement on backloading with a curtailment of the discretionary power proposed by the Commission – was conditioned by the double-edged nature of the state in regulating the force of value relations in carbon markets. NGOs have not achieved the permanent cancellation of allowances, but the backloading decision did pave the way for a 'market stability reserve', adopted just at the time of writing. The reserve, which will initially be made up of already back-loaded allowances, is set to function as an automatic backloading measure that adjusts auction volumes according to a set formula, thus avoiding discretionary state power, and is set to begin in 2019 (van Renssen, 2015).

The priority of value: 2030 climate and energy package

Contestation over the 2030 climate and energy package extended beyond reform within the EU ETS to its relationship with other policies. The 2030 package sets the broad framework for EU climate and energy policy between 2020 and 2030. The 2020 package, which set the framework for the prior decade, adopted a 'triple target' approach with separate emissions, renewables and energy efficiency targets. The so-called 20-20-20 model involved targets of a 20 per cent reduction in emissions, a 20 per cent reduction in energy consumption and a 20 per cent share of renewable energy by 2020, made up of binding national level targets. A central point of debate was whether this multi-pronged model should be extended, or be replaced, to a greater or lesser extent, by a single emissions reduction target to be met though the EU ETS. The substance of the debate was therefore the priority of the value relations created by carbon markets, versus other organising principles, in the EU's efforts to address climate change.

While the two previous cases were triggered in response to political pressure, the Commission initiated debate on the 2030 package as part of the periodic review and development of EU climate and energy policy. It released a Green Paper in March 2013 that acknowledged that EU ETS had "not succeeded in being a major driver towards long term low carbon investments" but nonetheless proposed a package that could fend off "national and sectoral policies undermining the role of the ETS and [the] level playing field it was meant to create" (European Commission, 2013a: 4). Connie

Hedegaard again played a prominent public role in selling this message by warning of the potential of the "renationalisation" of energy policy (van Renssen, 2013). To achieve its goals, the Commission proposed a 40 per cent emission reduction target by 2030 to be primarily achieved through the EU ETS. It also gave support for the continuation of the multiple instruments approach at the European level as an alternative to national level policies. However, the Commission stopped short of proposing specific targets for renewables and energy efficiency and instead simply stressed the need for policy "coherence" (European Commission, 2013a: 7–9). Different interpretations of policy coherence between corporate actors and environmental organisations dominated the ensuing debate.

The electricity and carbon-intensive manufacturing sectors were once again at odds over the stringency of the headline emissions target but were largely united in opposition to renewable energy and energy efficiency targets (CEFIC, 2013; CEMBUREAU, 2013; EURELECTRIC, 2013; EUROFER, 2013; EUROPIA, 2013). The arguments against such targets drew on market logic in arguing that specific renewables and efficiency policies undermined the cost efficient achievement of the emissions reduction target via the EU ETS. This position was articulated, for example, by E.ON, which argued that:

> Interference between the instruments EU ETS, [renewable energy] promotion schemes and [the] energy efficiency directive have resulted in conflicts and spoiled economic efficiency especially of the EU ETS. Consequently, climate change measures were unable to deliver the economically desired outcome (abate climate change at lowest costs) (E.ON, 2013b).

EDF expressed this concern with economic efficiency by reasserting the narrow emissions reductions logic of carbon markets, arguing "the development of renewable energy is not an end in itself but a means to decarbonise the economy alongside many others" (EDF Group, 2013). RWE summed up this overall position in advancing a "maxim of 'one target, one instrument'" guided by the principle of "as much of the market as possible, but as little state control as is necessary" (RWE, 2013). Much like the initial debates over the establishment of the EU ETS, the electricity industry used support for the EU ETS to defend against the adoption of other policies.

Environmental organisations took the opposite approach in arguing that a coherent policy approach required the inclusion of other measures. However, Friends of the Earth, Greenpeace and WWF – the three main European-level groups that participated in this formal policy debate – each adopted different strategies on the relationship between the carbon market and other policies. Friends of the Earth used support for alternative policies to challenge the market logic of the EU ETS. First, the organisation challenged the narrow focus on emissions reductions by pointing towards other benefits such as health improvements and the creation of jobs from alternative policies. Second, it challenged the narrow focus on cost efficiency by highlighting the importance of the very questions abstracted from in the commodification of carbon, by arguing:

> If we don't give guidance on how emission cuts will be made – by putting in place a coherent set of three targets – the door will be left open for false solutions like nuclear power, the replacement of coal with natural gas and unsustainable bioenergy, or carbon capture and storage (Friends of the Earth Europe, 2013b).

Greenpeace's emphasis was subtly different, not directly challenging the logic of carbon trading, but deprioritising the instrument in relation to other approaches. Greenpeace argued that a coherent climate and energy package would first look to maximise energy efficiency, and second meet the resultant lower energy demand with policies encouraging the deployment of renewables. Only after the potential of efficiency and renewables policy had been exhausted should the "remaining part of the required abatement…be driven by a well-functioning EU emissions trading scheme" (Greenpeace Europe, 2013). WWF's approach was different again, stressing the complementarities of other policies in achieving the cost efficient emissions reduction goal of carbon markets. WWF argued that "alone, a carbon price without complementary economic and policy support for savings and renewables is not the most economically efficient solution" (WWF Europe, 2013a).

Overlaying the contrasting industry and environmental movement positions on the priority of the carbon market were conflicts between national states over the level at which such decisions would be made. The strongest national state opposition to multiple targets came from heavily coal-dependent Central and Eastern countries in the Visegrad 4+ Group. They were led by Poland and included the Czech Republic, Slovakia, Hungary, Bulgaria and Romania (Ministry of the Environment, 2013). The UK also came out in opposition to renewables and efficiency targets, echoing polluting industry, in arguing that such targets "risk pre-judging the cost effective pathway to 2030 [greenhouse gas] outcomes" and "interact in a complex and unhelpful manner with other measures, notably the EU ETS" (Department of Energy and Climate Change, 2013). The position was clearly consistent with the UK government's support for shale gas and nuclear power, which would be disadvantaged by renewable energy and energy efficiency policy (Department of Energy and Climate Change, 2011).

Conversely, many other governments were in favour of a renewables target, including Germany, France, Denmark Italy, Austria, Belgium, Ireland and Portugal. Environment and energy ministers from these countries adopted a common position in the lead up to the Commission's proposal on the climate and energy package, arguing that a renewables target would "strengthen European competitiveness and lead to more jobs and growth" in the context of increasing global demand for renewable energy technologies (Mitterlehner et al., 2013). Many of the same ministers, from the governments of Belgium, Denmark, Germany, Greece, Ireland, Luxembourg and Portugal, made a similar case for an energy efficiency target (Wathelet et al., 2014). However, support for multiple targets from these countries only extended as far as the EU level, rather than the national level targets of the 2020 package. For example, the governments of France and Germany maintained that states should have sovereignty and flexibility over their energy mix (Presidency of the Republic of France, 2014). Therefore, national governments with different positions on the priority of value relations versus alternative criteria in climate policy were each conditioned by common imperatives for domestic control over responses to climate change.

The Commission's initial formal proposal, released on 22 January 2014, reflected the weight of arguments against the multiple target approach in heavily prioritising a single target and the role of the EU ETS in meeting it. In the proposal, the increase in the 2030 emissions reduction target to 40 per cent, from 20 per cent by 2020, was not matched by an equivalent increase in the renewable energy target, which would only rise from 20 to 27 per cent and not be binding at the national level, as it had been in the previous climate and energy package (European Commission, 2014a: 6). The impact assessment released alongside the proposal made it clear that the carbon market was the reason it did not consider higher renewable energy options, as such options "would result in continuing increases of the surplus of allowances in the EU ETS up to 2030 and would therefore seriously undermine the future relevance of the ETS in providing the right incentives for low-carbon investment" (European Commission, 2014j: 47). Instead, the 27 per cent renewables target was informed by its modelling on the bare minimum required to achieve the 40 per cent emissions target, to ensure no greater obligations beyond what was cost efficient. Six months later the Commission proposed to increase the energy efficiency target by slightly more than the renewables target but still less than the emissions target, to 30 per cent for the EU as a whole, from 20 per cent in the 2020 package. The Commission justified its proposal for an energy savings target that was 5 per cent above what it modelled as the minimum necessary for cost efficiency on the basis that reducing energy consumption was necessary to achieve energy security goals (European Commission, 2014g: 17).

The residualisation of the renewables target and the absence of national level targets in the Commission's proposals brought the UK government on board (Flynn, 2014). Similarly, the Visegrad countries maintained that there was "no need" for other targets, but described the Commission's proposed targets as "a step in the right direction" (Visegrad Group, 2014a, 2014b). The electricity industry and groupings of industry with direct interests in the adoption of renewables and efficiency targets both criticised the proposal from opposing positions. On one hand, the Magritte Group, which is made up of the CEOs of eleven large electricity and gas companies including top 20 polluters CEZ, Enel, Eni, E.ON, GDF Suez, Iberdrola and RWE, reiterated its support for a single emissions target to be met by a reformed carbon market alone (Magritte Group, 2014). On the other hand, the European Wind Energy Association stated that the "Commission has capitulated to anti-renewables lobby groups…the UK and other backward-looking Member States" with its "weak" 27 per cent EU level target (EWEA, 2014). Likewise, the

Coalition for Energy Savings, which represents industries such as insulation, and also includes environmental groups Friends of the Earth, WWF and CAN Europe, condemned the slowing of the rate of energy efficiency improvement represented in the proposed target (Coalition for Energy Savings, 2014). Both groups called for increased, nationally-binding targets. Friends of the Earth, Greenpeace and WWF were all individually scathing of the proposal, describing the proposed package as “totally inadequate,” a “sell-out” and a “recipe for failure,” respectively (Friends of the Earth Europe, 2014; Greenpeace Europe, 2014; WWF Europe, 2014).

The Parliament had limited power to influence the Commission’s proposal because it was made as a Communication. It nonetheless made some effort to increase the stringency of the targets to 40 per cent for energy efficiency and 30 per cent for renewables, by passing a non-binding resolution to this effect that was jointly proposed by the Environment and the Energy and Industry Committees, 341 votes to 263, with 26 abstentions on 5 February 2014. This position criticised the Commission’s proposal as “short-sighted and unambitious on a number of levels, specifically as regards the lack of national targets for renewable energy and of any meaningful new action to incentivise energy efficiency” (European Parliament, 2014).

The EU institution where it mattered most, the European Council, comprised of the heads of each member state, went in the opposite direction to the Parliament. The final package agreed to on 23-4 October 2014 accepted the Commission’s proposal for a 40 per cent emissions target and a 27 per cent renewables target but reduced the efficiency target to 27 per cent, though made it subject to a review that could increase it to 30 per cent. In the process, the EU ETS was explicitly affirmed as the primary emissions reduction instrument. Lastly, the European Council also announced its intention to extend the EU ETS to new sectors (General Secretariat of the Council, 2014). Thus, the 2030 climate and energy package saw a consolidation of the EU ETS, and the market-based paradigm more generally, through the prioritisation of the instrument, and its underlying value relations, over alternative measures.

Conclusion

The three cases in this chapter demonstrate that the EU ETS has indeed been actively constituted by a politics of market design involving a range of state institutions, industry groups and environmental organisations. The significant contestation over offset project type eligibility, the timing of carbon allowance auctions and the interplay between carbon markets and other instruments confirms that EU climate politics has indeed evolved beyond questions of support for or opposition to markets cautioned against in some of the post-structuralist literature. Understanding this contestation from the perspective of its impact on the reach, force and priority of value relations, as intensified by carbon markets, in climate policy helps answer the question of how the market-based approach has affected climate politics in relation to states, capital and social movements.

O'Connor (1998: 12) distinguishes between two concurrent and interrelated "moments" of struggle by social movements over the conditions of production. The first is over "the form in which 'nature' is appropriated, as a means of production of capital versus as a means of reproduction of civil society and human and other species life" and the second is over "the programs and policies of capital and state to restructure the production conditions." Both may occur "outside the state and also within and against the state." Struggles to limit the appropriation of carbon by capital have been substantially mediated by contestation over the EU ETS as the dominant form of state restructuring of production conditions in response to climate change in the EU. As the marketised form of state restructuring has become more embedded, most mainstream environment groups have shifted further away from hostility to carbon markets in favour of working towards their improvement.

The strategy of established organisations such as Greenpeace and WWF, and new carbon trading-focused groups Sandbag and Carbon Market Watch, has been to harness rather than challenge the role of value relations in organising the capitalist appropriation of carbon. While support for qualitative restrictions aimed to reduce the reach of value relations, it also aimed to redirect patterns of carbon commodification to achieve certain ends through the influence of carbon commodities elsewhere. The backloading debate was more explicitly about expanding the role of carbon markets in organising the appropriation of nature by enhancing the force of value relations. In the

2030 package, while Greenpeace attempted to deprioritise value relations by promoting alternatives, WWF sought to compliment the commodity form. Of the environmental groups that engaged in the formal policy process, Friends of the Earth was the main exception in seeking to undermine the role of value relations in organising the appropriation of nature. This was the case for each episode of carbon market reform, with Friends of the Earth using industrial gas offsets to oppose the CDM in general, abstaining from a backloading debate viewed as cementing the market-based approach and offering alternative policies in the 2030 package designed to replace the logic of carbon markets with explicitly social goals.

The success of the politics of market design can be assessed both in terms of immediate and longer-term policy outcomes. On both levels, success has been real, varied and limited. In the immediate term, industrial gas offsets were banned and allowance auctions were back-loaded. The campaigns that used these issues to delegitimise the carbon market are owed a great deal of credit for the outcomes. However, over the course of the formal political processes in the offset restriction and backloading debates, the potential effectiveness of each measure was eroded by the delaying and weakening of the final outcomes from the original proposals. In the longer term, both were agreed to in ways that limited the capacity for future reform of the same kind. Yet, some other reform has since taken place both areas, most notably the market stability reserve. Its long term impact remains to be seen, but the start date of 2019, two full decades since debate on the EU ETS first began, signals a disjuncture between the slow pace of reforms achieved through a politics of market design and the rapidly changing climate. While the crisis of carbon markets preserves existing patterns of fossil fuel use, the analysis in the previous chapter of the implications of a system of capitalised carbon also gives reason to doubt the effectiveness of higher carbon prices.

Given the shortcomings of both weakly and strongly implemented carbon markets, the residualisation of renewables and energy efficiency targets in the EU's 2030 package represents a serious setback for action of climate change. The need for such policies is acknowledged by MacKenzie (2008: 174), who states:

> The problem of combating climate change is much too far-reaching and complex to be solved by a single class of instruments such as emissions markets: direct regulation, large-scale public investment in research and development and in infrastructure, international aid, and (in contexts in which they are politically feasible) carbon taxes are all likely to be part of the necessary armoury, as is the removal of the many subsidies that exist globally for the extraction and use of fossil fuels.

While the 2030 outcome was stridently opposed by NGOs, there are continuities between it and the industrial gas and backloading cases. As a result of the depressed carbon market, in all three cases, the politics of market design became focused on the need to reform the EU ETS in order to save it. Arguments of this nature used to achieve reform in the first two cases were effectively deployed by capital to consolidate the EU ETS at the expense of alternative policies in the third case. In making the argument, capital was systematically advantaged by the economic logic of carbon markets, underpinned as it is by the ideology of nature discussed in Chapter Two.

The success of polluting capital in suppressing the expansion of alternative policies was not indicative of states automatically acting in the interests of capital. This was firstly complicated by competing positions of the electricity and energy-intensive manufacturing industries on basic questions over the role of the carbon commodity in organising the appropriation of carbon. For the electricity industry, which was more vulnerable to national measures, defending against alternative policies necessitated a stronger carbon market while energy-intensive manufacturing industries sought to limit such reform to what was considered necessary to restore the legitimacy of the instrument. In charting a middle course between these positions, states opted against conditions needed for the capitalisation of carbon to the detriment of the interests of financial capital, let alone capital with interests in renewable energy and energy efficiency.

Secondly, the analysis of the state is complicated by the array of national and international institutions involved in the regulation of the EU ETS. A key thread running through all of the cases was the tensions created by the use of carbon markets as a means to assert some degree of control over the production of climate change. This isn't a question of more or less state. The intensification of value relations via carbon markets requires an extensive state apparatus. But the capitalist, democratic and bureaucratic dimensions of states were faced with contradictions between expanding the value form, securing public support and maintaining their capacity to regulate production conditions according to their particular goals. Between these competing imperatives, the institutionalisation of the market-based approach pushed outcomes towards securing a greater role for capitalist value determinations in organising use of and access to fossil fuels through carbon markets.

Returning to this chapter's question, the marketisation of climate policy in the EU has shaped climate politics by encouraging sharp political contestation over carbon market reform while disadvantaging policy alternatives outside the market paradigm. The implications of this for the central question of the thesis is that, in political terms, the efficacy of the EU ETS, as a response to climate change, is additionally weakened by the negative effect of its institutionalisation on other climate policies, such as those that support renewable energy. This conclusion lends support to Swyngedouw's and Bailey and Maresh's arguments that post-political and technocratic forms of governance narrow political pathways. However, underscoring and extending McCarthy's observations, there are aspects of carbon market politics that don't entirely align with Swyngedouw's (2010: 225) contention that "the post-political disavows…antagonisms by displacing conflict and disagreement on to the terrain of consensually manageable problems, expert knowledge and interest intermediation." Capital's engagement with carbon markets continues to be primarily characterised by a defensive strategy rather than positive embrace. The general consensus of polluting capital over the continuation of the carbon market is a real political tactic shaped by concrete material interests. The post-political frame also risks glossing over the contradictions faced by state institutions in managing marketised forms of governance and thus failing to appreciate any political fragility in existing arrangements. Lastly, the Friends of the Earth example illustrates ongoing room for dissent even within the formal political process, supported by radical climate justice groups outside of it (Chatterton et al., 2013; Wainwright and Mann, 2013). Indeed, in other areas of climate policy, WWF, the most conservative environmental participant in the politics of redesigning the EU ETS, continues to campaign for direct regulation to ban shale gas mining in Europe, revealing that the organisation's subsumption to marketised policy is not complete (WWF Europe, 2013b).

A more critical perspective of any politics of market design is, however, required. O'Connor (1998: 310) provides a productive path forward by assessing the extent to which political demands move beyond a liberal project that seeks to "make democratic procedures work better on their own terms, without attacking the undemocratic or laissez-faire content of the liberal state" and instead adopts the more radical goal of "put[ting] democratic content into democratic forms (or procedures) of the bourgeois liberal state." Rather than juxtaposing the politics of market design with 'essentialist' for/against positions on carbon markets, as some of the post-structuralist literature is framed, this formulation provides an alternative means of analysing political practices in relation to carbon markets. It allows for an appreciation of the importance of the technical details of carbon markets, but from a critical perspective of their implications for establishing more democratic modes of state regulation of the climate. The campaigns for backloading, and against industrial gas offsets, can be distinguished on the basis that the former sought to enhance, and the latter sought to restrict, marketised decision-making over the appropriation of carbon. A politics of market design therefore contains some democratic possibilities under certain circumstances, while risking undemocratic outcomes in others. However, democratic and efficacious action on climate change also depends on building policy structures that use principles of socio-ecological sustainability, rather than value determinations, to prevent the appropriation of carbon. Here there is an important role for movements that oppose the devolution of decision-making over responses to climate change to carbon markets, because space remains to posit radical democratic alternatives. The urgent need for, and feasibility of, such policies is addressed in the Conclusion to this thesis.

8 – Conclusion

The contributions, limitations and implications of this thesis are distinguished by three major research themes that run through it: conceptualising capitalist social relations with nature, understanding climate change and evaluating carbon markets. In relation to the first research theme, the conceptual levels of appropriation, commodification and capitalisation offer a typology of social relations with nature that is grounded in the particular value system of capitalism. The concepts are used in different ways, often interchangeably, in critical Marxist studies of environmental change. Treating processes of appropriation, commodification and capitalisation as logically distinct but historically co-produced advances understandings not only of climate change, but of socio-ecological crisis more generally. Together, the concepts represent three crucial moments in the capitalist production of nature. This thesis, in developing Smith, Harvey and Swyngendouw's production of nature framework by conceptualising the internal relations between appropriation, commodification and capitalisation, also drew on the theoretical work of Benton, O'Connor, Burkett and Moore, and insights from a range of critical studies into market-based environmental policy. The connections and combinations made between these formulations demonstrate the ongoing possibilities of a productive dialogue between otherwise competing Marxist perspectives through particular conceptions of capitalist social relations with nature.

The World Bank's campaign to 'put a price on carbon' is just one component of a broader agenda to 'put a price on nature'. Corporations, governments and international institutions are putting a great deal of work into extending the market-based climate policy approach to address issues such as biodiversity loss, degraded ecosystems and endangered species (Spash, 2011). Conceptions of the appropriation, commodification and capitalisation of nature directs research on new rounds of more complex marketisation, in these and other areas, towards the relationship between the causes of, and responses to, environmental problems. As demonstrated in this thesis in relation to 'carbon', the three conceptual levels can be used to uncover how the marketisation of nature is conditioned by, and impacts on, capitalist social relations with nature. A focus on the appropriation of nature reveals that processes of commodification in market-based environmental policy represent, in different ways, capitalism's insatiable drive to expand by replacing labour with natural conditions, which drives the production of socio-ecological crisis. In this reading, the significance of the commodification of nature is the substitution of particular instances of this general process in market exchange. However, the concept of commodification, the level at which most related critical research has been conducted, only takes the analysis so far. It must be complimented by an appreciation of the capitalisation of nature in order establish how capitalism's value system (re)organises the appropriation of nature in the context of marketised policy.

The focus in this thesis on carbon represents a partial understanding of the ways in which nature is appropriated, commodified and capitalised in the global capitalist economy. Indeed, owing to the 'end of pipe' regulatory structure of the EU ETS, its understanding of the relationship between capital and carbon is largely limited to the point of fossil fuel combustion, rather than processes of extraction, processing and transportation. But the analysis of the relationship between the uneven development of capital and the uneven organisation of carbon within the scope of the EU ETS, made possible by the creation of an original database, contributes to understandings of climate change as a fundamentally unequal problem. This second research theme builds on other critical interventions, in particular those that stress geographical differentiation between countries in the global North and South (e.g. Agarwal and Narain, 1991), by emphasising ownership links and polluting infrastructure as other key axes of social differentiation in the production of climate change. In contrast to the externalisation and universalisation of the causes of climate change by orthodox economists, the clustering of responsibility for greenhouse gas emissions among a relatively small number of publicly and privately owned corporations, and their biggest polluting power stations and factories, is a product of the abstract logic of capital and concrete patterns of capital accumulation. Capitalism's tendency towards the socio-spatial concentration and centralisation of capital has been produced through the socio-spatial concentration and centralisation of emissions, with the aid of fossil fuels, the corporation and the state as conditions for its historical realisation.

Other less uneven organisations of emissions are not necessarily incompatible with capitalist development. Additional empirical research mapping the organisation of capital and carbon in different historical periods and geographical regions, or sectors not currently regulated by the EU ETS, is needed in order to extrapolate the understanding of climate change developed in this thesis more generally. The latter task was recently assisted by a Commission Regulation establishing, in non-EU ETS sectors, similar emissions reporting requirements to those that generated the data used to create the companies database (European Commission, 2014i). Further, Heede's (2013) landmark study of "carbon majors" suggests that the concentration and centralisation of emissions is a broader phenomenon. The study calculates historical responsibility for global greenhouse gas emissions between 1751 and 2010, focusing primarily on upstream sectors, in particular mining companies. Despite using a different carbon accounting method compared with the downstream one used in this thesis, Heede found, similarly, that only 90 public and private entities are cumulatively responsible for 63 per cent of carbon dioxide and methane emissions globally. Running counter to this research, the orthodox economic displacement and dispersal of responsibility for the production of climate change complements wider ideas, expressed in notions such as the Anthropocene, that are based on the "erasure of capitalism's historical specificity and the attendant implication that capitalism's socio-ecological contradictions are the responsibility of all humans" (Moore, 2014b: 4). The uneven organisation of emissions in the EU ETS between corporations and states underscores the extent to which such an approach conceals and distorts understandings of climate change.

Smith (2008: 247) argues that the point of replacing ideologies of nature with an appreciation of the production of nature within processes of capital accumulation "is to insist that responses to environmental crises are more likely to be successful to the extent that this crisis is accurately assessed." This thesis' conceptualisation of capitalist social relations with nature and its understanding of climate change are foundations of the third research theme on evaluating the efficacy of carbon markets in addressing climate change. Answering this central research question, with reference to the pollution movements, financial practices and policy contests that constitute the EU ETS and its links with the Kyoto mechanisms, showed the market-based policy approach has entrenched the production of climate change in a number of ways. Efficacious climate policy, by definition, addresses the nature of the problem at hand. The gulf between the outcomes of carbon markets and the socio-ecological, economic and political dimensions of this goal indicates the necessity of alternative approaches and some principles on which such policies should proceed.

The EU ETS and its links to the Kyoto mechanisms reproduce the orthodox economic external-universal ideology of nature in practice. The externalisation of responsibility to address climate change from the biggest polluters is predicated on its universalisation through the market. This is the case not only in terms of the dispersal of climate action that occurs by switching between differentiated forms of carbon appropriation, but also the wider displacement of costs, which, in the case of the spatio-temporal fix of the CDM/JI, is global in reach. Building an account of the commodification of carbon out of an understanding of capitalist appropriation underscores why equivalence, a prominent theme in existing critical literature on commodification in carbon markets, is significant: the potential for polluting capital to exploit unevenness in the production of climate change in the face of political and regulatory pressures.

The assessment in this thesis that trading relationships by actors involved in the EU ETS and the Kyoto mechanisms entrench the existing organisation of emissions is based on criteria that are incommensurable with that of orthodox economics. Castree (2003: 289–91, 2008a: 168) appeals that "we need to know just what, precisely, is wrong with the capitalist commodification of specific natures and why" and whether it is based on an internal or external set of criteria. The normative basis for the argument that it matters when, where, why, how and by whom emissions are reduced is external to the rationale of carbon markets. Although based on fundamentally different understandings of social relations with nature, there are parallels between notions of the exploitation of unequal contributions to the climate problem and orthodox economic ideas of differing marginal abatement costs, which justifies abstraction from the content of emissions reductions in the search for economic optimality. The case for this policy goal collapses when then magnitude and urgency of the required transformation is considered.

To reach the EU's long-term emissions reduction goals, the Commission has stressed the need for early investments, stating "the power generation system would have to undergo structural change and achieve a significant level of decarbonisation already in 2030 (57-65% in 2030 and 96-99% in 2050)" (European Commission, 2011a: 6). Similarly, the IPCC has found that placing the world on an emissions pathway that limits global warming to the EU's and UNFCCC's goal of 2 degrees Celsius requires "substantial shifts in annual investment flows during the period 2010 – 2029" (Edenhofer et al., 2014: 104). The incrementalist approach that supports the substitution of marginal for potentially transformative actions on climate change within carbon markets is at odds with these goals. Climate change is not a marginal problem. The transitions envisaged by the Commission and the IPCC cannot be achieved without substantial and specific action from the corporations that control significant portions of polluting infrastructure, including RWE and E.ON. However, the case studies of the EU ETS's two biggest polluters in this thesis are limited by their illustrative nature. There is significant scope for more comprehensive quantitative analysis of carbon trading between EU ETS and Kyoto mechanism participants that accounts for the qualitative character of trading relationships.

The analysis in this thesis of the implications of the emergence of a system of capitalised carbon is also complicated by the effects of a range of factors other than carbon markets. Whether the intensification of capitalist value relations through the institution of a more potent EU ETS entrenches the production of climate change by disciplining fossil fuels use, and thus cementing the most profitable polluting practices, is a question that will be co-determined by these factors. In Europe's electricity industry, unsustainable debt levels and falling share prices in the major utilities are symptoms of other major challenges. Advances in distributed energy technology and its uptake by households and new renewable energy businesses and community organisations threatens a 'death spiral' for the centralised, fossil fuel-powered energy model that organises most of the top EU ETS polluters (Gray, 2015). Research that situates the circulation of value through carbon commodities within broader circuits of capital in carbon-intensive industries, accounting for the appropriation, commodification and capitalisation of other natural conditions, is important to better understand the intersection between the pressures exerted by carbon markets and other pressures threatening to leave polluting assets stranded. The latter scenario, however, does not represent a plan to rapidly transition to a clean energy economy, highlighting the need for alternatives to carbon markets.

The more immediate research concern, though, is the implications of the weakness, rather than strength, of global carbon markets. This thesis has progressed political economy narratives to account for the discrepancy between contentions that carbon markets are an accumulation strategy and the crisis of accumulation being witnessed ten years on from the start of the EU ETS. Financial interests in carbon markets have not cohered a corporate coalition in favour of wide-ranging climate action that can challenge fossil fuel interests. Rather, the absence of state support for the accumulation strategy has seen dwindling participation from financial capital, while bolstering the defensive strategy of carbon-intensive industry. This strategy, evident since initial negotiations for the Kyoto Protocol, is supported by the carbon market crisis because imperatives to save the EU ETS provide added weight to the arguments of polluting capital against renewable energy and energy efficiency policy. Carbon markets have indeed reinforced existing and unsustainable patterns of accumulation, but through the breakdown, not realisation, of the accumulation strategy. This is most evident in the success of carbon-intensive industry in consolidating the market-based approach at the expense of alternative options, which entrenches the production of climate change by deprioritising measures that could address the problem. As investment bank UBS said in 2011, "by 2025, the ETS will have cost consumers 210 billion euros. Had this amount been used in a targeted approach to replace EU's dirtiest plants, emissions could have dropped by 43 percent, instead of almost zero impact on the back of emissions trading" (Szabo and Coelho, 2011).

The structural disadvantages to more direct approaches created by the market-based policy paradigm cautions against post-structuralist arguments for a politics of market design. Seeking to shape, rather than challenge, the role of the commodity form in organising climate policy undermines the potential for alternatives to emerge out of growing recognitions of the shortcomings carbon markets, evident in the commentary of UBS. Nonetheless, campaigns to ban particular offset types have successfully limited the reach of value relations, as intensified by carbon markets, and renewable energy and energy efficiency targets will continue to play a role alongside carbon markets at the EU level. A more complete picture of the political outcomes of the institutionalisation of carbon markets could be achieved through continued research on the development of climate policy at the national level and the activities of environmental organisations outside formal debates on the EU ETS. Indeed, significant elements of the climate movement are campaigning beyond carbon markets in ways that confront the socio-spatial organisation of emissions, with considerable success. Both the spatial concentration, and the social centralisation, of emissions has been targeted in growing incidences of non-violent direct actions on large-scale fossil fuel infrastructure and the divestment campaigns against the biggest corporate polluters (Klein, 2014).

These recent orientations from the climate movement provide principles that governments should adopt in formulating climate policy. The concentration and centralisation of emissions in the EU ETS makes planning a transition away from fossil fuels much more feasible than suggested by the apparent complexity of the policy problem (Garnaut, 2011; Stern, 2007). Renewable energy policy has been shown to address climate change in many parts of the world because it requires the transformation of polluting infrastructure, not just in sectors covered by the EU ETS, but also alongside the electrification of the transport sector. Energy efficiency policy that lowers total energy consumption is essential for getting there because it reduces overall investment requirements (Couture and Leidreiter, 2014). Combining these two policy areas to create strict timetables to replace the largest polluting facilities with clean alternatives, implemented by directly targeting the small number of publicly and privately owned corporations that own them, represents the most efficacious path to a zero carbon economy.

The regulatory feasibility of such an approach is even greater for national governments than for the EU as a whole; the top 20 ultimate owners control three-quarters and above of EU ETS emissions in all countries with matched 2005-12 emissions in the companies database. Extensive state control over emissions places governments in a particularly strong position to immediately address, rather than marketise, their own significant direct contribution to climate change. This applies not only to state-owned companies such as Vattenfall that pollute across multiple national jurisdictions, but also to smaller state-owned corporations that nonetheless dominate emissions at the national level. Indeed, states control over one-quarter of emissions in half of all countries in the companies database with matched 2005-12 emissions.

The central position occupied by governments in the production of climate change refutes the economic ideology that only the price system can possibly know the best way to reduce emissions. Yet, carbon markets translate this notion into a policy framework that fundamentally denies the potential for democratic decision-making over pathways to a safe climate. Through such processes, governments could organise climate policy on the basis of community-determined goals, based on principles of socio-ecological sustainability, rather than capitalist calculation. The choice between alternative approaches looms large over ongoing international climate meetings, held under the auspices of the UNFCCC, where negotiators, attempting to build a post-Kyoto architecture, continue to debate texts that are littered with references to new and expanded market mechanisms (UNFCCC, 2015b). An approach that directly targets the largest corporate and state polluters would face obstacles including enhanced corporate strategies to evade accountability and state institutions that, after decades of marketisation in all areas of public policy, are disinclined to make necessary investments in renewable energy and energy efficiency. However, moving towards regulation and planning of this kind would also place the terms of climate politics on a more democratic, and climate-friendly, footing.

9 – Appendix

Method for companies database matching process

Three sources of installation level data were used in the matching process to create the companies database:

1. **The list of stationary (i.e. non-aviation) installations in the European Union Transaction Log (EUTL) published on 27 February 2014** (European Commission, 2014l). The list provides national company identification and European value added tax (VAT) numbers for the majority of installations.

2. **2008-12 National Allocation Plan (NAP) tables** (available from European Commission, 2014n). NAPs were used in the first two phases of the EU ETS by national governments to outline the distribution of free allowances to installations. The tables outlining each installation's allocation also include the name of their 'operator'. Operators are defined by the EU ETS Directive as the "natural or legal persons" that "operate or control" or have "decisive economic power over the technical functioning of" an installation (European Parliament and Council, 2014: Article 3f,g). Mostly, this is interpreted by governments in the NAP tables as the company that owns the installation, although there are inconsistencies between the reporting of subsidiary vis-à-vis parent companies.

3. **Operator holding account information in the EUTL** (European Commission, 2014i). Each installation is linked to an operator holding account for their allowances that is used for receiving allocations, trading with other accounts, and surrendering for compliance. The name of operator holding accounts are in most cases also the name of the company that owns them (whether subsidiary or parent), although in some cases it is the name of the person that manages the account.

The matching process was conducted in two stages. First, national company identification numbers and European VAT numbers from source (1) were numerically matched with the corresponding numbers in the *Orbis* database. This was the most precise method because the reported company numbers are unique and closest to the direct owners of installations. This method was used for matching the majority (11,506; 86%) of stationary installations in the companies database. Second, NAP operator names and operator holding account names in sources (2) and (3) were textually matched with company names in *Orbis*. This matched the remaining installations (1,948; 14%) in the companies database. This was the second most accurate matching process due to the risk that installations were matched with the wrong companies that have the same owner name. To avoid incorrect matching, textual matches were manually checked with country, sector and legal company registration details and incorrect matches were excluded. Operator holding account names that were of people managing the accounts rather than companies, most common in French installations, were also manually excluded from the matching process. Most operator holding account and NAP operator names are the same, but where they differed (usually due to different levels of the same company being reported) and company matches were found for both, the most direct owner with the most complete parent information was used. This latter process was also used to match person holding (i.e. trading only) accounts with companies.

Coverage of companies database by installation country, size, activity and sector

The installation and emissions coverage of the companies database can be broken down by country, installation size, polluting activity and sector. This also gives a general picture of the makeup of the EU ETS. Owing to unevenness between countries in the availability of company identification numbers, as well as gaps in the *Orbis* database, some countries have a higher percentage of installations matched than others. 22 out of 31 countries have over 90 per cent of installations matched and 25 out of 31 have over 80 per cent matched. These include the ten countries with the most installations. Excluding Cyprus, Lichtenstein and Malta, which have very few installations (27, 2, and 4 respectively), only Denmark (58%), Greece (70%) and Ireland (52%) had a lower matching success rate. However, these three countries each had a much higher proportion of emissions matched (97%, 99% and 95% respectively). Indeed, with the exception of Cyprus, Malta and Lichtenstein, as well as Croatia and Iceland which only have verified emissions from 2013, all countries have over 95 per cent of emissions matched, and 22 out of the 29 countries with 2005-12 verified emissions have 99 or 100 per cent matched (see Table 9.1).

The higher percentage of emissions vis-à-vis installations indicates that the matching process was more successful in larger installations, which tend to be owned by larger companies that are more likely to be in the *Orbis* database. Breaking down the companies database using the European Environment Agency's installation sizes shows that for installations with positive verified emissions between 2005 and 2012, matching success increases with each installation size, with 99 per cent of large installations, and close to 100 per cent their emissions, matched. Nonetheless, the vast majority of mini installations – 88 per cent of installations representing 90 per cent of emissions – were also matched (see Table 9.2).

The EU ETS Directive includes "associated activities" within the definition of an installation and it is up to individual member states to apply the definition and determine the boundaries of the installation through their role in issuing emissions permits to operators (European Parliament and Council, 2014: Article 3b). This has led to some discrepancy between countries, where a similar industrial site may be considered as more than one installation in one country and a single installation in another (European Commission, 2010b: 4). This is one of many examples where the partly decentralised regulatory structure of the EU ETS prevents the availability of perfectly comparable data across countries. Most installations, however, have straightforward boundaries (Guillaume and Bellassen, 2015: 147), which means the inter-country installation definition problem has minimal impacts on the analysis of the scale of polluting facilities in this thesis.

The coverage of the companies database can also be measured according to the 'activities' that led to the emission of greenhouse gases from installations. The original EU ETS Directive outlined nine activities that define the scope of the EU ETS, which was subsequently expanded from phase three, and has provisions for other activities on an opt-in basis. All EU ETS activities have over 90 per cent of their installations matched except primary aluminium (76%) and ceramic firing (87%) and all but primary aluminium (87%) and non-ferrous metals (64%) have over 90 per cent of their emissions matched (see Table 9.3 [excludes aviation and carbon capture and storage]). Although some of these activities only existed from 2013 onwards, some register 2005-12 emissions in Table 9.3 because the installations covered by the new activities were previously classified differently.

Most activities are relatively specific in their description of the good produced, process used and/or scale of production at the installation (European Parliament and Council, 2014: Annex I). The exception is the wide-ranging 'combustion installations with a rated thermal input exceeding 20 MW' activity, which the majority of installations (63%), representing the majority of 2005-12 emissions (73%), are classified as. National state authorities have applied this category in different ways, ranging from a more narrow definition encompassing power and heat generation for sale to third parties to a broader one which also includes combustion processes used internally in manufacturing processes (European Commission, 2006a). Therefore, it is useful to break down the database by sector in order to get more information about combustion installations, and because sectoral information provides other useful information on the social context of installations more generally. The European Commission (2014d) has provided NACE Revision 2 (NACE Rev. 2) sector codes, which are used by statistical authorities in the EU, for 92 per cent of installations (13,401 out of 14,617, representing close to 100% of emissions). An additional 1,052 installations without NACE Rev. 2 codes were assigned to installations in the companies database using the NACE Rev. 2 sector that their directly matched company is classified under in *Orbis*. This is an approximation due to the possibility that the installation's activities do not fall into the company's main sectoral classification, but provides sectoral information for all but three installations in the companies database.

Of the installations with sector codes, 92 per cent are either broadly in the manufacturing or electricity and gas sectors and represent 98 per cent of total emissions. The electricity and gas sector represents 65 per cent of total emissions and manufacturing 33 per cent. The matching rate for installations in the electricity and gas and manufacturing sectors was 95 and 94 per cent, respectively. Both have over 99 per cent of emissions matched. Other, less significant sectors in terms of numbers of installations and quantity of emissions are more varied. For example, only 27 per cent health sector installations and 22 per cent of their emissions were matched. The poor matching success rate is attributable to the dominance of public authorities that are not companies in the health sector, which are less likely to be in the *Orbis* database of companies. However, health sector installations only represent 1 per cent of installations and 0.1 per cent of emissions, which means such problems have very little impact on the conclusions drawn in the thesis (see Table 9.4).

Table 9.1: Companies database breakdown by country

Country	Installation count	Installations matched	Installation percentage	05-12 emissions (Mt CO_2-e)	05-12 emissions matched (Mt CO_2-e)	Emissions percentage
Austria	249	242	97%	247	247	100%
Belgium	434	425	98%	404	404	100%
Bulgaria	165	155	94%	218	216	99%
Croatia	47	43	91%	N/A	N/A	N/A
Cyprus	27	5	19%	56	40	71%
Czech Republic	445	431	97%	627	627	100%
Denmark	430	248	58%	207	200	97%
Estonia	58	56	97%	107	107	100%
Finland	678	659	97%	297	296	100%
France	1,280	1,155	90%	945	919	97%
Germany	2,429	2,353	97%	3,699	3,693	100%
Greece	184	128	70%	528	522	99%
Hungary	278	263	95%	195	195	100%
Iceland	5	4	80%	N/A	N/A	N/A
Ireland	127	66	52%	153	146	95%
Italy	1,436	1,377	96%	1,646	1,642	100%
Latvia	113	103	91%	23	23	99%
Liechtenstein	2	1	50%	0.04	0.02	49%
Lithuania	116	105	91%	49	49	100%
Luxembourg	20	18	90%	18	18	99%
Malta	4	0	0%	22	0	0%
Netherlands	577	526	91%	643	636	99%

Country	Installation count	Installations matched	Installation percentage	05-12 emissions (Mt CO_2-e)	05-12 emissions matched (Mt CO_2-e)	Emissions percentage
Norway	155	145	94%	96	96	100%
Poland	1,016	1,002	99%	1,617	1,617	100%
Portugal	312	286	92%	233	233	100%
Romania	282	236	84%	329	320	97%
Slovakia	216	211	98%	187	187	100%
Slovenia	103	98	95%	67	67	100%
Spain	1,324	1,228	93%	1,240	1,237	100%
Sweden	877	872	99%	157	157	100%
United Kingdom	1,228	1,013	82%	1,937	1,917	99%
Total	14,617	13,454	92%	15,946	15,809	99%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 9.2: Companies database breakdown by installation size

Size	**Installation count**	**Installations matched**	**Installation percentage**	**05-12 emissions (Mt CO_2-e)**	**05-12 emissions matched (Mt CO_2-e)**	**Emissions percentage**
Zero	1,914	1,772	93%	N/A	N/A	N/A
Mini	7,288	6,434	88%	317	287	90%
Small	1,825	1,735	95%	345	331	96%
Medium	2,587	2,521	97%	2,224	2,180	98%
Large	1,003	992	99%	13,061	13,011	100%
Total	14,617	13,454	92%	15,946	15,809	99%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 9.3: Companies database breakdown by activity

EU ETS Directive activity	Installation count	Installations matched	Installation percentage	05-12 emissions (Mt CO_2-e)	05-12 emissions matched (Mt CO_2-e)	Emissions percentage
Combustion installations	9,197	8,409	91%	11,689	11,593	99%
Manufacture of ceramic products by firing	1,642	1,436	87%	94	88	94%
Manufacture of glass	476	460	97%	163	159	98%
Manufacture of mineral wool	8	8	100%	1	1	100%
Metal ore roasting or sintering installations	14	14	100%	40	40	100%
Mineral oil refineries	175	170	97%	1,167	1,160	99%
Other activity opted-in	636	610	96%	134	126	94%
Production of adipic acid	2	2	100%	0	0	N/A
Production of ammonia	19	19	100%	11	11	100%
Production of bulk chemicals	176	174	99%	30	30	100%
Production of carbon black	4	4	100%	1	1	100%
Production of cement clinker or lime	630	605	96%	1,362	1,352	99%
Production of coke	24	24	100%	156	156	100%
Production of glyoxal and glyoxylic acid	1	1	100%	0	0	N/A
Production of hydrogen and synthesis gas	28	28	100%	0	0	N/A
Production of nitric acid	19	19	100%	0.2	0.2	100%
Production of pig iron or steel	300	291	97%	853	851	100%
Production of primary aluminium	29	22	76%	2	2	87%
Production of pulp, paper and board	954	882	92%	240	236	98%
Production of secondary aluminium	25	23	92%	0.4	0.4	100%
Production of soda ash and sodium bicarbonate	9	9	100%	0	0	N/A

EU ETS Directive activity	**Installation count**	**Installations matched**	**Installation percentage**	**05-12 emissions (Mt CO_2-e)**	**05-12 emissions matched (Mt CO_2-e)**	**Emissions percentage**
Production or processing of ferrous metals	164	163	99%	2	2	100%
Production or processing of gypsum/plasterboard	27	25	93%	1	1	100%
Production or processing of non-ferrous metals	58	56	97%	0.3	0.2	64%
Total	14,617	13,454	92%	15,946	15,809	99%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

Table 9.4: Companies database breakdown by sector

Sector (NACE Rev.2)	**Installation count**	**Installations matched**	**Installation percentage**	**05-12 emissions (Mt CO_2-e)**	**05-12 emissions matched (Mt CO_2-e)**	**Emissions percentage**
Accommodation and food service activities	1	1	100%	0.1	0.1	100%
Administrative and support service activities	10	9	90%	3	0	6%
Agriculture, forestry and fishing	158	129	82%	11	9	84%
Construction	42	42	100%	0.3	0.3	100%
Electricity, gas, steam and air conditioning supply	5,283	5,004	95%	10,326	10,271	99%
Financial and insurance activities	26	26	100%	0.1	0.1	100%
Human health and social work activities	180	48	27%	11	2	22%
Information and communication	14	14	100%	0.4	0.4	100%
Manufacturing	7,942	7,477	94%	5,266	5,224	99%
Mining and quarrying	366	356	97%	277	266	96%
N/A	164	3	2%	13	0.03	0%
Other service activities	2	2	100%	0.1	0.1	100%
Professional, scientific and technical activities	40	37	93%	1	1	95%
Public administration and defence	34	6	18%	1	0.3	19%
Real estate activities	28	28	100%	1	1	100%
Social security	49	12	24%	3	1	24%
Transportation and storage	150	148	99%	28	28	100%
Water supply; sewerage, waste management	80	64	80%	3	3	97%
Wholesale and retail trade; repair of motor vehicles	48	48	100%	0.3	0.3	100%
Total	14,617	13,454	92%	15,946	15,809	99%

Sources: Own calculation using Bureau van Dijk (2014) and European Commission (2014d, 2014i, 2014l, 2014n)

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