Making Things the Same:

Gases, Emission Rights and the

Politics of Carbon Markets

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This paper analyses the development of carbon markets: markets in permits to emit greenhouse gases or in credits earned by not emitting them. It describes briefly how such markets have come into being, and discusses in more detail two aspects of the efforts to ‘make things the same’ in carbon markets: how different gases are made commensurable, and how accountants have struggled to find a standard treatment of ‘emission rights’. The paper concludes by discussing the attitude that should be taken to carbon markets (for example by environmentalists) and the possibility of developing a ‘politics of market design’ oriented to making such markets more effective tools of abatement.

Around the world, markets in permits to emit greenhouse gases or in credits earned by not emitting them are emerging. Some already exist; others are in construction.[1] This article describes briefly the route – at the level of 'policy' – that has led to their emergence. It then delves a little deeper into the conditions of possibility of these markets, by examining two examples of what it takes to make the entities traded in these markets 'the same'. The examples are how the destruction of one gas in one place is made commensurate with emissions of a different gas in a different place, and how accountants have sought (so far with only limited success) to make 'emission rights' equivalent. Finally, the article discusses the issue of politics: the question of the attitude that should to be taken to carbon markets (for example by environmentalists, especially those who conceive of themselves as opponents of 'capitalism'), and the tightly-related issue of the process of market design viewed, as it has to be, as politics.

Although the article draws upon the 'finitist' perspective sketched briefly below (see Barnes, Bloor and Henry, 1996; Hatherly, Leung and MacKenzie, forthcoming), its approach is prompted by the view of economic life suggested by the 'actor-network' theory of Michel Callon and Bruno Latour (for which see, for example, Latour, 2005). In Callon's and Latour's view, the characteristics of an 'actor' – a term which, following semiotics (especially Greimas, 1987), they view as encompassing more than just human beings – are not intrinsic, but are the result of the networks of which the actor is made up and forms part. What we call 'capitalism', for example, is not an entity with fixed characteristics. 'Que faire contre le capitalisme?', they write: 'D'abord évidemment *ne pas y croire*' (Callon and Latour, 1997, p. 67). What is to be done against capitalism? First of all, of course do not believe in it.

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[1] This paper was originally presented to the workshop 'Carbon Markets in Social Science Perspective', Durham University, 7 November 2007. The research was supported by a UK Economic and Social Research Council Professorial Fellowship, RES-051-27-0062, and I am deeply grateful to the Institute of Advanced Study, Durham University for supporting the workshop and for a Fellowship which enabled me to complete the paper.

In Callon's and Latour's view, economic life is 'performed' – framed and formatted – by 'economics at large', a term that encompasses not just the academic discipline but also economic practices such as accounting and marketing (Callon 1998 & 2007). The characteristics of economic actors and of markets arise from, amongst other things, the 'dispositifs de calcul' (Callon and Muniesa 2003) – the calculative mechanisms – of which they are made up.

If the characteristics of 'capitalism' are not inherent, they can be changed by changing the calculative mechanisms that constitute it. The markets in greenhouse-gas emissions that are being constructed globally are a set of experiments (Muniesa and Callon 2007) in the validity of this prediction. Hitherto, greenhouse-gas emissions have been, in economists' familiar terminology, an 'externality': from the viewpoint of the emitter, they bore no cost, and so did not figure in emitters' economic calculations. The goal of a carbon market is to bring emissions within the frame of economic calculation by giving them a price. In such a market, emissions bear a cost: either a direct cost (because allowances to emit greenhouses gases need to be purchased), or an opportunity cost (because allowances that aren't used to cover emissions can be sold, or because credits can be earned if emissions are reduced below 'business as usual'). A carbon market is thus an attempt to change the construction of capitalism's central economic metric: profit and loss, the 'bottom line'.

The experiments in carbon-market construction have scarcely begun, so the validity of the prediction that capitalism can be 'civilized' (Latour forthcoming) by changing calculative mechanisms remains undecided. We do not yet know whether the bottom line will be changed to any substantial extent, in particular to an extent sufficient to keep global warming below the threshold (uncertain and fiercely contested, but often taken to be 2^{o}C) beyond which the risk of severe impacts rises sharply (Schellnhuber, 2006).

In consequence, this paper is necessarily preliminary. The empirical material on which I am drawing is limited. It consists primarily of a set of 24 interviews conducted with people involved with carbon markets (particularly with the European Union Emissions Trading Scheme) as market designers, as carbon traders and brokers, or as members of NGOs seeking to influence the evolution of carbon markets. This interview material is supplemented by analysis of relevant documents such as monitoring reports and contributions to the debate in accountancy touched on below.

The article's main aim is simply to help broaden social-science research on carbon markets, both in terms of its disciplinary base (though their origins lie in economics, carbon markets cannot be understood by the conventional tools of that discipline alone) and in terms of its empirical focus. In that latter respect, I hope to show that it is productive to investigate not just overall questions such as the reasons why policy-makers might choose carbon markets rather than other tools to combat global warming, but also the specifics of how carbon markets are constructed. Whether or not carbon markets are environmentally and economically effective depends on such specifics, and the issues involved are various and demand interdisciplinary treatment. One of the two topics examined below – how different gases are made commensurable – is a natural question for the social studies of science and technology; the other – how to find a standard treatment of 'emissions rights' – is a question obviously suitable for researchers in accounting. Although for reasons of space I do not discuss them here, questions for other disciplines can also easily be identified: for example, vastly more needs known about how emission reduction projects in developing countries actually work in practice, a question that raises issues ranging from how verification is conducted to the impact of projects on local communities and local environments. Investigating such issues in genuine depth required the skills of, amongst others, anthropologists and other area specialists.

Because the specifics of market design matter, I make no apology for the fact that this article touches upon matters of apparent detail. The commensurability of gases and the accounting treatment of emission rights are inevitably 'technical' questions, and those technicalities cannot altogether be avoided: they matter to overall outcomes. The commensurability of gases, for example, is crucial to how the world's two main existing carbon markets – the European Union Emissions Trading Scheme and the Kyoto Protocol Clean Development Mechanism – interrelate, while there is at least tentative evidence that the accounting treatment of emissions rights affects firms' behaviour in carbon markets. It is precisely issues of this detailed kind that an effective, inter-disciplinary analysis of carbon markets will need to address.

Carbon markets

Carbon markets come in two main species: 'cap and trade' and 'project-based'.[2] Let me begin with the former. It involves a government or other authority setting a 'cap' – a maximum allowable aggregate total quantity of emissions – and selling or giving the corresponding number of allowances to emitters. The authority then monitors emissions and fines anyone who emits without the requisite allowances. If the monitoring and penalties are stringent enough, aggregate emissions are thus kept down to the level of the cap. The 'trade' aspect of cap and trade arises because those for whom reductions are expensive will want to buy allowances rather than incurring disproportionate costs. The requisite supply of allowances is created by the financial incentive thereby provided to those who can make big cuts in emissions relatively cheaply. They can save money by not having to buy allowances, or (if allowances are distributed free) can earn money by selling allowances they don't need. So, as already noted, emissions, which previously had no monetary cost, now have one.

The origins of the idea of controlling emissions via a cap and trade scheme can be traced to the work of Nobel Laureate Ronald Coase (1960), but a more proximate source is the University of Toronto economist J.H. Dales, who first put forward the idea in something like full-fledged form (1968 a&b).[3] Emissions markets were implemented in relatively minor and sometimes ham-fisted ways in the 1970s and 1980s, mainly in the United States (see, e.g., Hahn, 1989). It was only in the 1990s that the idea became mainstream.

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[2] This article concentrates on regulatory markets, largely setting aside the 'voluntary' market, in which, for example, firms choose to 'offset' their emissions, even though they are under no compulsion to do so: see, for example, Bumpus and Liverman, (forthcoming).

[3] The history of emissions trading will be treated in more detail in MacKenzie (forthcoming, chapter 7). The brief account given here draws upon that in MacKenzie (2007).

The crucial development was the start of sulphur-dioxide trading in the US in 1995 (for which see, especially, Ellerman et al., 2000 and Burtraw et al. 2005). It had been known for twenty years or more that damage to the environment and to human health was being caused by sulphur-dioxide emissions, notably from coal-fired power stations, which react in the atmosphere to produce 'acid rain' and other acid depositions. Numerous bills were presented to Congress in the 1980s to address the problem, but all failed in the face of opposition from the Reagan administration and from Democrats who represented states that might suffer economically from controls on sulphur dioxide, such as the areas of Appalachia and the mid west in which coal deposits are high in sulphur.

Sulphur trading broke the impasse. It combined a simple, clear goal that environmentalists could embrace (reducing annual sulphur-dioxide emissions from power stations in the US by ten million tons from their 1980 level, a cut of around a half) with a market mechanism attractive to at least some Republicans. The cut was achieved in practice far more cheaply than almost anyone had imagined. Industry lobbyists had claimed it would cost $10 billion a year, while the actual cost was around $1 billion. Allowance prices of $400 a ton were predicted, but in fact prices averaged around $150 or less in the early years of the scheme. The flexibility that trading gave to utilities helped to reduce costs (by around a half compared to having to meet a standard that imposed a uniform maximum emission rate: see Ellerman et al., 2000 and Burtraw et al., 2005) but other factors were equally important. 'Scrubbers' to remove sulphur from smokestacks turned out to be cheaper to install and to run than had been anticipated, and rail-freight deregulation sharply reduced the cost of transportation from Wyoming's Powder River Basin, the main source of low-sulphur coal in the United States (Ellerman et al., 2000).

That the sulphur-dioxide market was, broadly, a success shaped how the Clinton Administration approached the negotiations that led to the 1997 Kyoto Protocol. In the Protocol, the industrialised nations undertook that by Kyoto's 2008-12 'commitment period' they would have limited their greenhouse-gas emissions to agreed proportions of their 1990 levels: 93 per cent for the US, 92 per cent for the European Community overall (with varying levels for its member states), and so on.

At the insistence of the US, Kyoto gave its signatories sulphur-like flexibility in how to meet their commitments. The Protocol contains provision for a cap and trade market between nation states. States with caps they will exceed can pay others that in the commitment period are emitting less than their caps for their unneeded 'Kyoto units' (quantities of carbon dioxide or their equivalents in other gases: see below). Just how much trading of such units between nation states there will be remains to be seen: it is possible it will be quite limited. More significant so far have been two other Kyoto mechanisms – 'Joint Implementation' and, especially, the 'Clean Development Mechanism' (CDM) – which are project-based schemes, not cap and trade.

Let me concentrate on the CDM (for which see, for example, Lecocq and Ambrosi 2007), which is the more important of the two. It is a crucial – perhaps *the* crucial – aspect of the Kyoto Protocol (Grubb 1999), crystallizing the political compromise at the Protocol's heart, between the refusal of developing countries to take on emissions caps and the Clinton Administration's conviction that global emissions could be restrained far more cheaply if the developing world were part of the Kyoto regime. The CDM allows the creation of Kyoto units from projects in developing countries approved by the Executive Board of the CDM (a body established under the United Nations Framework Convention on Climate Change).

To gain approval, it must be shown that a project is 'additional' (that it would not take place without CDM funding) and that it will reduce emissions below the 'baseline' level they would have been at without the project. A developing-world entity, or industrialized-world government, corporation, bank or hedge fund can then earn the difference between emissions with and without the project in the form of a specific type of Kyoto units: 'Certified Emission Reductions' (CERs). A CER is a credit, not a permit or allowance: it doesn't *directly* convey any right to emit. However, some governments are purchasing CERs as a way of meeting their Kyoto caps, and crucially CERs also have monetary value because the European Union permits its member states to issue allowances in the most important cap and trade market, the European Union Emissions Trading Scheme (ETS), in exchange for the surrender of CERs (European Parliament, Council, 2004). A credit earned in, for example, China or India can thus be transformed into a permit to emit in Europe.

As with the CDM, the ETS, launched in January 2005, was shaped by political exigencies.[4] What pushed Europe towards trading rather than its initial preference, harmonized carbon taxes, was in good part an idiosyncratic feature of the political procedures of the European Union. Tax measures require unanimity: a single dissenting country can block them. Emissions trading, in contrast, counts as an environmental, not a tax matter. That takes it into the terrain of 'qualified majority voting'. No single country can stop such a scheme: doing so takes a coalition of countries sufficiently populous (since voting weights roughly follow population) to form a 'blocking minority'. A plan for a Europe-wide carbon tax had foundered in the early 1990s in the face of vehement opposition from industry and from particular member states (notably the UK), and its advocates knew that if they tried to revive it the unanimity rule meant they were unlikely to succeed. 'We learned our lesson', one of them told me in interview. Hence the shift in allegiance to trading.

In terms of volume of transactions, the ETS is the largest greenhouse-gas market. The scheme has had its difficulties – the over-allocation, violent price fluctuations and 'windfall profits' discussed below – but it saw trades worth $24bn in 2006 (World Bank 2007, p. 3). The prospect of 'monetizing' CERs via the ETS is the main driver of investment in Clean Development Mechanism projects, which generated CERs worth $5bn in 2006 (World Bank 2007, p. 3). Between them, the ETS and CDM form the core of the world's carbon markets, and it is on them that this paper focuses.

Making things the same: Gases

The political decision to create a carbon market such as the CDM or ETS is not the same as constructing such a market. A new commodity – an emission allowance or emission credit – needs brought into being: defined legally and technically, allocated to market participants, made transferable and tradable, and so on. To give a flavour of what is involved, let me concentrate on one issue: the heterogeneity of the means by which the 'sameness' – the fungibility of allowances and credits – necessary for a

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[4] On the emergence of the ETS, see, e.g., Zapfel and Vainio (2002), Christiansen and Wettestad (2003), Damro and Méndez (2003), Wettestad (2005), Cass (2005).

carbon market is brought into being.[5] Consider, for example, two very different sites: the central-area combined heat and power plant of Edinburgh University, situated a couple of hundred metres from my office there, and the refrigerant plant operated by Zhejiang Juhua Co., 6.5 km south of Quzhou City in China's Zhejiang province. How is the activity at one made commensurable with that at the other, so that both can form part of the same market, and CERs at Zhejiang Juhua's plant can be equivalent to the ETS allowances that a European emitter such as Edinburgh University needs?

As its name indicates, the combined heat and power plant in Edinburgh generates electricity (by burning natural gas in a device that resembles a giant car engine), and uses what would otherwise be waste heat to warm up nearby buildings. Because its thermal input capacity is slightly greater than the 20 MW threshold of the European Union Emissions Trading Scheme, this plant became part of the ETS in January 2008. (Most such installations have been part of the scheme since its launch in 2005, but Edinburgh University was exempted from the first phase because of its involvement in an earlier, voluntary UK emissions trading scheme.) CO_2 emissions from the combined heat and power plant are measured using a gas corrector meter (the interface of which is shown in figure 1) on the large pipe that takes gas from the national gas grid into the plant. It is called a 'corrector meter' because it samples temperature and pressure, and can thus convert volumes into masses of gas input, which are in turn converted to estimates of CO_2 output using standard multiplication factors.

Zhejiang Juhua Co. is involved in something quite different, the manufacture of HCFC-22 (chlorodiflouromethane), which is used mainly as a refrigerant (especially in air conditioners), though also as a foam blower and as a chemical feedstock. The standard process used to produce chlorodiflouromethane involves combining hydrogen fluoride and chloroform, using antimony pentachloride as a catalyst, and even when optimized the process leads to a degree of 'overfluoridation':

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[5] On commensuration in the SO_2 market, see Levin and Espeland (2002).

trifluoromethane, HFC-23, is produced as well.[6] HFC-23 is, unfortunately, long-lived in the atmosphere and an efficient absorber of infrared radiation; the combination makes it a very potent greenhouse gas.

Until recently, the HFC-23 was discharged into the atmosphere. Now, the Zhejiang Juhua plant's waste gases are fed into a specialised incineration furnace imported from Japan, in which they are mixed with hydrogen, compressed air and steam, burned at 1200^0C using a high-intensity vortex burner, and thus converted to hydrogen fluoride, carbon dioxide and hydrogen chloride. These products pass through a quencher (in which they are cooled rapidly to minimise the formation of dioxins), and the resultant acid solution is either sold or disposed of via a facility for treating fluoric waste (CDM Executive Board 2007).

As already noted, to gain approval it must be shown that a Clean Development Mechanism project reduces emissions below the 'baseline' level they would have had in the absence of the project, which in many cases is a tricky exercise in establishing a credible counterfactual (Lohmann 2005): for an introduction to the issues involved, see Michaelowa (2005). In the case of HFC-23 decomposition, however, a straightforward argument has sufficed: without the decomposition process, the HFC-23 would, as already noted, simply have been discharged into the atmosphere (CDM Executive Board 2007). The amount actually decomposed then needs measured, but in such a way that a connection is kept to the baseline of the HFC-23 that would have been emitted in the absence of the decomposition incinerator. (The quantity of HFC-23 generated is affected by the precise parameters of the HCFC-22 production process, and hence there is a need to reduce the incentive to operate the process in an unoptimized way and generate unnecessary HFC-23 in order to earn credits by destroying it.) So to standard equipment such as flow meters and a gas

[6] 'HFC-23' and 'HCFC-22' are not standard chemical formulae, but instances of a code, widely used in the refrigerant business, for identifying haloalkanes. The standard formula for trifluoromethane is CHF_3, but 'HFC-23' is how it is referred to in carbon markets.

chromatograph is added a regulation: for each tonne of HCFC-22 produced, there is a maximum mass of HFC-23 whose decomposition can earn credits.[7]

Crucially, the allowable mass of HFC-23 that the measurement devices reveal has been decomposed is then multiplied by 11,700.[8] By decomposing a tonne of HFC-23 in China, one can – via the link between the CDM and ETS – earn allowances to emit 11,700 tonnes of CO_2 in Europe. Certified Emission Reductions are now a major income stream for China's refrigerant plants, and for the Chinese government (which imposes a 65 percent tax on them, hypothecated for environmental purposes). Indeed, HFC-23 decomposition is the biggest single sector of the Clean Development Mechanism, accounting for 67 percent of the CERs generated in 2005 and 34 percent of those generated in 2006 (World Bank 2007, p. 27). Since the price of CERs is likely to be a chief determinant of the European carbon price – and thus, for example, a major input into electricity prices – the effects of the commensuration are considerable.

The crucial figure, 11,700, is the product of a calculation of the 'global warming potential' (GWP) of HFC-23 published by the Intergovernmental Panel on Climate Change. Set up in 1988 by the World Meteorological Organization and United Nations Environmental Programme, the IPCC has as its remit the

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[7] The mass of HCFC-22 produced (which is determined by weighing shipping containers and storage tanks) determines the 'eligible quantity' of HFC-23: the quantity for the incineration of which credits can be earned. For each tonne of HCFC-22 produced by the standard antimony pentachloride process, the eligible quantity of HFC-23 is 0.0137 tonnes, corresponding to the lowest recorded emission level from a process optimized to minimize HFC-23 production (see McCulloch 2005, p. 11.) The mass of gas fed into the incinerator is determined from the readings of a flow meter, and the concentration of HFC-23 in it is determined by gas chromatography of periodic samples. (A correction for leakage is also applied.) The product of mass of gas (in tonnes) and HFC-23 concentration, up to the maximum given by the eligible quantity, is, as noted in the text, then multiplied by 11,700 to give the quantity of Certified Emission Reductions earned (SGS United Kingdom Ltd., 2007).

[8] I'm grateful to Thomas Grammig and to members of the audience of a talk I gave at the University of Oxford for sparking my interest in how gas equivalents are brought into being.

establishment of authoritative scientific knowledge about climate change (see Agrawala 1998 a & b). As the IPCC put it in 1990, GWP is '[a]n index ... which allows the climate effects of the *emissions* of greenhouse gases to be compared. The GWP depends on the position and strength of the absorption bands of the gas, its lifetime in the atmosphere, its molecular weight and the time period over which the climate effects are of concern' (Houghton, Jenkins and Ephraums 1990, p. 45). Although very similar notions are to be found in the scientific literature of the time (see, e.g., Lashof and Ahuja 1990), it was the IPCC itself that gave 'global warming potential' its canonical definition:

$$GWP = \frac{\int_{O}^{TP} a_x[x(t)]dt}{\int_{O}^{TP} a_r[r(t)]dt}$$

x designates the gas in question (e.g. HFC-23). a_x is an estimate of the effect on the radiation balance at the tropopause (the boundary of the upper and lower atmosphere) of an increase in the amount of gas in the atmosphere, an effect measured in watts per square metre per kilogram. $x(t)$ is the mass of the gas that will remain in the atmosphere at time t from l kg released at time zero. TP is the overall time period in question: in the calculation in the HFC-23 commensuration, it is 100 years. The denominator is the equivalent integral for the reference gas, CO_2.

The expressions in this equation inscribe complex processes. $r(t)$, for example, isn't (and obviously couldn't be) determined by releasing a kilogram of carbon dioxide and measuring what happens over a century: it is a mathematical function generated from a standard model (the Bern model: see, e.g., Siegenthaler and Joos 1992) of the exchange of carbon between the atmosphere, the oceans and the terrestrial biosphere. a_x and a_r, likewise, are in part the products of sophisticated spectroscopic studies, recorded largely in a database managed by the Harvard-Smithsonian Center for Astrophysics. (The database was originally a military project, designed to enhance understanding of absorption of infrared radiation with a view to improving the detection of heat sources: see Taubes 2004.) But a_x and a_r also assume a scenario that is believed to be helpful in predicting the climatic impact of a gas. In this scenario, temperatures in the stratosphere, which are understood as adjusting relatively quickly to such perturbations, have done so, while temperatures in the lower atmosphere and at the earth's surface (which adjust only slowly) have not.[9] Again, the scenario cannot be observed empirically, so modelling as well as spectroscopy is involved in the determination of a_x and a_r.

In 1990, the IPCC felt able to offer estimates of the GWPs of only 19 gases, not including HFC-23, and it labelled the figures 'preliminary only' (Houghton, Jenkins and Ephraums 1990, p. 59 and table 2.8, p. 60). By 1995-6, the list had expanded to 26, and included HFC-23, the GWP of which was estimated as 11,700 (Houghton et al. 1996, table 2.9, p. 121). Both the notion of 'global warming potential' and the IPCC's mid-1990s estimates of GWPs were then inscribed into the Kyoto Protocol, which laid down that they should be used to translate emissions of other greenhouse gases into their equivalents in CO_2 and that the IPCC's mid-1990s estimates should be used until the end of the 2008-12 commitment period.[10]

The 'exchange rate' of 11,700 used to translate HFC-23 into CO_2 is thus an example of 'black-boxing' in the sense of Callon and Latour (1981) and MacKenzie (1990, p. 26). GWPs could be contested in at least two senses. First, whether GWPs really give the best estimates of the climatic effects of different gases could be and has been challenged (see Shackley and Wynne, 1997, and also Shine et al., 2005, and the literature cited in the latter): for example, the choice of a 100-year time period is in a sense arbitrary, and very different GWPs can be generated if, for example, 25, 50 or 500 years is used.[11] Second, GWP estimates were acknowledged to be subject to

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[9] 'The long-term forcing is ... more accurately represented by that acting after the stratosphere has returned to a state of global-mean radiative equilibrium. Studies with simple models show that the climate response, that is, the surface temperature change, is proportional to the radiative forcing when the radiative forcing is defined in this way ... Importantly, the proportionality constant is found to be the same for a wide range of forcing mechanisms' (Pinnock et al. 1995: 23227).

[10] See article 5, paragraph 3 of the Kyoto Protocol, the text of which is available at http://unfccc.int/resource/docs/convkp/kpeng.html, accessed 24 March 2006.

[11] Amongst other criticisms is 'the fact that, despite its name, the global *warming* potential does not purport to represent the impact of gas emissions on temperature. The GWP uses the time-integrated radiative forcing and this does not give a unique indication of the effect of pulse emissions on

significant uncertainties, of the order of +/- 35 percent (Houghton et al., 1996, p. 73 and p. 119). By 2007, for example, the consensus estimate of the global warming potential of HFC-23 had increased from 11,700 to 14,800 (Intergovernmental Panel on Climate Change 2007, p. 212). Neither of these two forms of challenge, however, has spilled over into the carbon market. GWPs, with their apparent simplicity and the black-box 'possibility of use by policy-makers with little further input from scientists' (Shine et al., 2005, p. 297) remain the way in which different gases are made commensurable, and the inscription of the mid-1990s' estimates of GWPs into the Kyoto Protocol means that uncertainties and the changing estimates of GWPs remain inside the black box: a matter for technical specialists, not carbon traders.

This black-boxing is crucial to allowing carbon markets to encompass greenhouse gases other than CO_2: liquidity in such markets would be greatly reduced if the relevant 'exchange rate' between gases had to be negotiated *ad hoc* for each transaction. Note that the black boxing rests upon a 'social' factor: the authority of the Intergovernmental Panel on Climate Change. Although that authority has been challenged by climate change 'sceptics' and 'deniers', public controversy has focused on the reality, extent of and evidence for anthropogenic climate change, not on matters of 'detail' such as GWPs, debate over which has taken place only in much more limited circles. The IPCC's authority in such detailed matters is thus an essential part of 'making things the same' in carbon markets, by keeping the 'exchange rates' between gases inside the black box and separate from political and economic disputes.

It is perfectly possible, however, that this black-boxing may become harder in the future. At the time of the Kyoto Protocol, it is unlikely that anyone imagined that

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temperature, because of large differences in the time constants of the various greenhouse gases. Although a strong greenhouse gas with a short lifetime could have the same GWP as a weaker greenhouse gas with a longer lifetime, identical (in mass terms) pulse emissions of the two gases could cause a different temperature change at a given time. Economists have also criticised the GWP concept for not being based on an analysis of damages caused by the emissions' (Shine et al., 2005, p. 282).

the figure of 11,700 for the global warming potential of HFC-23 would determine a flow of funds of the order of $3.5 billion (the likely total value of credits from HFC-23 decomposition up to 2012: see Wara 2007). As negotiations begin over a successor to Kyoto, however, the financial consequences of such figures can now be seen. It is possible that GWPs will remain in practice unchallenged – it would be very hard, given the diversity of economic interests involved, to get agreement on a measure other than GWPs, or on anything other than the IPCC's estimates of them (which are a 'focal point' in game-theoretic terms), so no party to the negotiations may attempt to do so – but it is not a foregone conclusion.

Making things the same: 'Emission rights'

Gases are thus made the same by a combination of measurement devices, complex natural science, and the capacity (at least so far) of the Intergovernmental Panel on Climate Change to keep the estimation of global warming potentials bracketed off from carbon-market politics. But practices of many other kinds are also needed to make 'carbon' fungible, and amongst these accounting is of particular importance.[12] The European allowances that Edinburgh University needs to emit carbon dioxide and the CERs generated by Zhejiang Juhua Co. are items that Europe's (or indeed China's) accountants have not previously encountered. What kind of items are they? What accounting treatment should they receive? These questions are significant for the operation of carbon markets, since accounting makes economic items visible, and whether and how it does so is consequential.[13]

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[12] I am deeply grateful to Allan Cook, who served as Co-ordinator for the International Financial Reporting Interpretations Committee at the end of the period in question for his help in the research underpinning this section. Cook (forthcoming) is his own account of these events. For broader legal debate over the nature of carbon credits and allowances see Wemaere and Streck (2005).

[13] The issue of devising appropriate frameworks for making carbon emissions 'visible', for example in corporate accounts, has received considerable attention: see, for example, the work of Fred Wellington and his colleagues at the World Resources Institute (such as Lash and Wellington 2007) and the Prince's Charities (2007). How to account for emissions allowances, however, has received much less attention: see Cook (forthcoming) and Casamento (2005).

Hatherly, Leung and MacKenzie (forthcoming) argue that a 'finitist' perspective is useful for the analysis of accounting, especially of accounting classification, and it is particularly appropriate here. In this perspective, how to classify an item (not just an accounting item, but an item of any kind) is always implicitly a choice. Past classifications – which are always finite in number, hence 'finitism' – influence present classifications by analogy ('this item is like previous items we classified as X, so this should be classified as an X'), but do not determine them.

Of course, classification often does not *feel* like a choice. Classifiers – bookkeepers, accountants, ornithologists, botanists, and so on – often, probably normally, come across items that seem familiar and simply 'see' them as an X ('this *is* an X', not 'I am classifying this as an X'). Items that seem to classifiers to be unfamiliar are thus of particular analytical interest, because they make implicit choice explicit. Instead of relying on habit and routine, those involved have consciously and explicitly to decide what classification is appropriate, and the debate that is often sparked can reveal the contingencies that affect classification.

In the run-up to the launch of the European Union Emissions Trading Scheme, the International Financial Reporting Interpretations Committee (IFRIC), a subsidiary body of the International Accounting Standards Board, discussed how to apply accounting standards to the new items, which it called 'emission rights', which were about to come into being. What kind of items were they? For example, were they indeed 'rights'? The IFRIC concluded that they were not: 'an allowance itself does not confer a right to emit. Rather it is the instrument that must be delivered in order to settle the obligation that arises from emissions' (IFRIC 2004, p. 19).[14]

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[14] 'It therefore follows that a participant in a cap and trade scheme does not consume the economic benefits of an allowance as a result of its emissions. Rather a participant realises the benefits of that allowance by surrendering it to settle the obligation that arises from producing emissions (or by selling it to another entity). Therefore, the IFRIC observed that amortisation, which is the systematic allocation of the cost of an asset to reflect the consumption of the economic benefits of that asset over its useful life, is incompatible with the way the benefits of the allowances are realised. Although the

An allowance was, however, in the IFRIC's view clearly an asset. But what was its nature? Was it an 'intangible asset' – 'An identifiable non-monetary asset without physical substance' (IASB 2005, p. 2227) – and thus within the scope of International Accounting Standard (IAS) 38? Or was it a 'financial instrument' – a 'contract that gives rise to both a financial asset of one entity and a financial liability or equity instrument of another entity' (IASB 2005, p. 2219) – and thus within the scope of the standard governing such instruments, IAS 39? Some of those who commented on the IFRIC's initial draft argued that an allowance was indeed a financial instrument, but the IFRIC disagreed: though allowances 'have some features that are more commonly found in financial assets than in intangible assets' – such as being 'traded in a ready market' – they were not financial instruments (IFRIC 2004, p. 21).

An allowance was thus, in the IFRIC's view, an intangible asset, and therefore governed by IAS 38. If governments issued allowances at less than their market value (as noted, most have issued them free-of-charge) the difference was, IFRIC decided, a 'government grant', and its accounting treatment should therefore follow the relevant standard, IAS 20. Emissions themselves – as noted, previously outside an economic or accounting frame – now had to come within it. The emissions of those governed by cap-and-trade schemes should, said the IFRIC, be treated as giving rise to liabilities that were 'provisions' whose treatment should follow IAS 37 (IFRIC 2004, p. 7).

The IFRIC's conclusions – crystallised in *IFRIC Interpretation 3: Emission Rights*, issued in December 2004, on the eve of the start of the European Union

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IFRIC agreed that this observation pointed to precluding amortisation, it agreed with those respondents who highlighted that in some cases such a requirement could be inconsistent with the requirements of IAS [International Accounting Standard] 38. The IFRIC therefore decided not to proceed with its proposal ... that allowances should not be amortised. Nonetheless, for most allowances traded in an active market, no amortisation will be required, because the residual value will be the same as cost and hence the depreciable amount will be zero.' (IFRIC 2004, pp. 22-23).

Emissions Trading Scheme – thus made 'emission rights' the same by laying down a homogeneous approach to accounting for them, in which, for example, an allowance received free by an industrial company or bought by an investment bank were both treated in the same way as intangible assets. However, IFRIC 3 encountered strong opposition, with critics arguing that the relationship of IFRIC 3 to the three relevant standards – IAS 20, 37 and 38 – would create accounting mismatches, especially in the light of anticipated changes to IAS 20, which if made will mean that non-repayable government grants have to be recognised when they are received (see Cook forthcoming). For example, the fair value of the allowances that a company received free would have to be recognised immediately as income, while the costs of the corresponding emissions would be recognised only gradually as they accumulated.

Reflecting the criticism of IFRIC 3, the European Financial Reporting Advisory Group told the European Commission in June 2005 that the interpretation 'will not always result in economic reality being reflected', and recommended that the Commission not endorse it.[15] The following month, the International Accounting Standards Board, while defending IFRIC 3 as 'an appropriate interpretation' of existing accounting standards, acknowledged that it 'creates unsatisfactory measurement and reporting mismatches' and withdrew it.[16]

There was, of course, a 'bottom line' issue underpinning the controversy surrounding IFRIC 3. Corporations generally fear earnings volatility: there is a widespread conviction that investors prefer earnings that rise smoothly to those that fluctuate, even around the same underlying trend. IFRIC 3 threatened to produce volatility that, in its critics' eyes, would be artificial. For example, the advantage, for corporations, of classifying an 'emission right' as a financial instrument would have been that it would make available the 'hedge accounting' treatment permitted under IAS 39. If allowances could 'be treated as the hedging instrument of a forecast

[15] Letter from Stig Enevoldsen to Alexander Schaub, 6 May 2005. Available at http://www.iasplus.com/interps/ifric003.htm, accessed 11 June 2007.

[16] International Accounting Standards Board, 'IASB withdraws IFRIC Interpretation on Emission Rights', available at http://www.iasplus.com/interps/ifric003.htm, accessed 11 June 2007.

transaction (ie future emissions)' (IFRIC 2004, p. 20), then allowances and the corresponding emissions would offset each other. If a company received *N* free allowances, forecast emissions of *N* tonnes of carbon dioxide, and emitted *N* tonnes, then its earnings would at no point be affected. 'Carbon' would thus remain invisible.

The withdrawal of IFRIC 3 means that it remains permissible to treat carbon in this way: as inside an economic frame, but in a sense invisibly so, since no accounting recognition is needed if the above conditions are met. A survey by Deloitte (2007) found that some market participants were doing just that. Others were in effect following IFRIC 3, while others again were doing so partially, treating the provision for the liability created by emissions in a different way.[17] The attempt to make 'emission rights' the same has, in this sense, so far failed.

The partial invisibility of carbon also means that the incorporation of the carbon price into the market's 'calculative mechanisms' (Callon and Muniesa 2003) is only partial. Although it is impossible to be certain, there is tentative evidence from my interview data of effects of both the accounting visibility of carbon in some firms and its invisibility in others. Consider, for example, the effect of the European Union Emissions Trading Scheme on electricity prices. If allowances are distributed free, one might naïvely think that they should have no effect on the price of electricity. If a generator is given enough allowances to cover its emissions (most generators have actually had to buy some allowances, but let me set that aside), what

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[17] Deloitte (2007) does not estimate the relative prevalence of the three forms of accounting treatment. Those in the third category 'recognise a provision on the following bases:

- To the extent that the entity holds a sufficient number of allowances, the provision should be recognized based on the carrying value of those allowances (i.e., the cost to the entity of extinguishing their obligation)
- To the extent that the entity does not hold a sufficient number of allowances, the provision should be recognized based on the market value of emission rights required to cover the shortfall; and
- The penalty that the entity will incur if it is unable to obtain allowances to meet their obligations under the scheme, and it is anticipated that the penalty will be incurred (note that the obligation to deliver allowances must still be fulfilled).' (Deloitte 2007, p. 3)

it charges customers surely shouldn't change? An economist will quickly tell you what's wrong with that argument. As already noted, there's an opportunity cost involved. In a 'perfect market', a profit-maximizing firm will produce electricity only if the price it receives is greater than what it can earn by not generating electricity and selling its stocks of the required inputs: its coal, its gas, and now its carbon allowances (Point Carbon 2007, pp 24-25). If its allowances can command a non-zero price, the price of electricity must rise correspondingly.

According to an interviewee in the electricity market, however, it has required accountants to give force to this economists' reasoning. The 'naïve' view prevailed in the industry until explicit valuations of allowances started to be made. The price effect 'should' have been manifest in forward contracts covering supply from January 2005 (the start of the ETS) onwards, but apparently it initially wasn't.[18] The effect began in the UK only once January 2005 was reached, and analysis by the consultancy Point Carbon (2007) suggests it was even slower to appear on the Continent. (Once the effect began, the result in the UK was, for example, an increase in domestic electricity prices in 2005 of around 7 percent[19] – for example, about £20 on a £300 annual bill – and it is increases of this kind that are the source of the much-

[18] This is an interviewee's assertion. Unfortunately, I do not have access to the price data needed to test it quantitatively.

[19] Calculation by Karsten Neuhoff, quoted on BBC Radio 4, 'File on Four', 5 June 2007. Controversy is growing across Europe about these 'windfall profits'. In the UK, for example, the energy regulator Ofgem has called for the windfall profits of the UK's electricity generators in the 2008-12 phase of the Emissions Trading Scheme – which Ofgem estimates at £9bn – to be used to help customers in fuel poverty (Crooks 2007). In Germany, the Bundeskartellamt (Federal cartel office) charged electricity generator RWE with behaving illegally by incorporating in the price it charged industrial consumers the market value of permits it had received free. The case was settled out of court in September 2007, with RWE continuing to defend its pricing but agreeing that in 2009-12 it would hold annual auctions of quantities of power almost equivalent to its annual sales to German industry (46,000 GWh in total over the 4 years) and transfer to the purchasers, free of charge, the corresponding carbon allowances if it had received these at no cost (RWE AG 2007).

criticized ‘windfall profits’ that electricity generators have made from the Emissions Trading Scheme.)

Carbon has thus been ‘visible’ for some time in the electricity sector. When, in contrast, carbon is kept invisible in accounting terms effects of three kinds can be anticipated. The first, which is hypothetical (I have no direct evidence on the point), would be to undermine a major desired effect of a carbon market: incentivizing even those companies who have ‘enough’ allowances to cut their emissions so as to generate income by selling allowances. For this effect to be realised, allowances need to be seen as assets with potential monetary value, not simply as means of complying with regulatory requirements. The second, related effect (of which there is some tentative evidence) is to delay the sale of allowances by those who, even without abatement, have more allowances than they need. The sale of allowances – and also lending allowances for short sale – means that they can no longer be kept invisible. They must be recognized in accounting terms, and, for example, a tax liability may be crystallized. This disincentive may reinforce other reasons for not selling, such as the fact that emission levels will in general be known in advance only approximately and the lack of a culture of proprietary, risk-taking trading in many industrial companies (in contrast to electricity suppliers, which are active traders) that would permit the sale of allowances that probably – but not certainly – will not be needed.

My interview data do not permit me to judge the relative importance of the various reasons for postponing the sale of allowances that are likely to be surplus to requirements, but those interviewees with whom I explored the topic all believed delayed sale to be a real phenomenon. It has been consequential because the complex process of setting national allocations for the first phase (January 2005 to December 2007) of the European scheme led to over-allocation of allowances. The extent of over-allocation was, however, not clear initially, and the failure of those who were ‘long’ allowances to bring them to market led to a constriction of supply, which helped market prices to rise to €31/tonne (see figure 2). Curiously, when the extent of over-allocation became clear in the spring of 2006, prices – though plunging dramatically – did not initially fully reflect the fact that allowances no longer had any significant economic value. It took several months for the market price of a phase-one European allowance to fall close to zero (only in 2007 did prices become in effect zero, with allowances towards the end of the year costing less than €0.10/tonne). Interviewees suggested that delayed sale by those who were 'long' allowances accounts for this paradoxical behaviour of the carbon price. Even though it was clear that allowances were intrinsically close to worthless (because, in aggregate, there were more of them than would be needed), they still commanded a price of several euros, because not enough were brought to market.[20]

The third – again hypothetical – effect of the accounting invisibility of carbon may be to strengthen the hand of managers whose interests lie in protecting market share by not passing on to customers the opportunity cost of allowances that have been allocated free, even when passing on the cost is profit-maximizing for their firms. The extent to which firms pass on the opportunity cost is crucial to the environmental effects of a cap-and-trade market – if they pass it on, there is likely to be carbon 'leakage' from the scheme, as imports from outside its boundaries become more attractive – and there is fierce controversy over likely behaviour in this respect. Economists tend to predict profit-maximization, cost pass-through and thus leakage, while firms themselves tend to argue that market share will be protected and costs will not be passed through, at least in full. Unfortunately, empirical analysis of the Emissions Trading Scheme so far is too limited to be confident how firms outside the electricity sector have behaved in this respect: see Carbon Trust (2008).

The politics of carbon markets

One could go deeper into the issue of fungibility, of making things the same. A trade, for example, is a legal transaction requiring documentation, and with three bodies (the International Swaps and Derivatives Association, the European Federation of Energy Traders, and the International Emissions Trading Association) competing in this sphere, interviewees reported that it has taken orchestrated action to reduce the differences to a level at which a trade documented in one format can be regarded as similar enough to one documented in another, for example for one to be used to hedge the other. There has also, for instance, been sharp criticism from competitors of the efforts by Barclays Capital, a leading player in the carbon market, to standardise

[20] One interviewee, at a hedge fund, reported making a considerable amount of money by taking a short position in allowances in this period.

CERs via its SCERFA (Standard CER Forward Agreement). The competitors regard a SCERFA as specific to Barclays, not as a 'standard' entity.

Instead, however, let me consider the question of the attitude to be taken to carbon markets. There is a great deal of suspicion of them, ranging from rightwing distaste for emissions caps to leftwing hostility to an extension of market relations. The efforts at market construction so far have led to some environmental benefits – for example, because of HFC-23's potency, curbing emissions of it is very valuable – but also significant problems. There has, for example, been only modest abatement by Europe's electricity producers (the sharp rise in gas prices in 2005-6 swamped any carbon-price incentive to switch from coal to gas), while the mechanism discussed above led them, as noted, to make substantial windfall profits.

Similarly, the large sums that can be earned by decomposing HFC-23 also create substantial profits, because the costs of decomposition are modest. A specialised incinerator of the kind needed costs around $4-5 million to install and $20,000 a month to run (McCulloch 2005, p. 12). Even with China's 65 percent tax, a large HCFC-22 plant can recoup the installation cost in a few months and go on to earn revenues of well over a million dollars a month. There is debate over just how much the subsidy increases HCFC-22 production: McCulloch (2005) argues that because the cost of HCFC-22 is only a small proportion of the costs of the products in which it is used,[21] a reduction in the price of HCFC-22 will not expand the market for it very much. However, the *de facto* subsidy may slow the replacement of HCFC-22 by more environmentally friendly refrigerants. (HCFC-22 is an ozone depleter, the use of which as a refrigerant will eventually be phased out under the Montreal Protocol governing such substances, and it is also a greenhouse agent, though not as potent as HFC-23.) Because of fears of this kind, 'new' HCFC-22 production (i.e. over and above 2000-4 levels) is currently not eligible for CDM credits, but the consequence is that there is no economic incentive not simply to discharge HFC-23 from such new production into the atmosphere rather than decomposing it.

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[21] An air conditioning unit retailing at $500-1000 needs less than a kilogram of HCFC-22, which costs around $1 to $2 (McCulloch 2005, p. 7).

In the light of issues such as these, it is tempting to conclude that carbon markets are inherently flawed means of achieving abatement. As Michel Callon (1998) points out, constructing a market requires an enormous degree of 'cooling': of knowledge, of metrologies, of actors, of identities, of interests. In a perceptive article, Lohmann applies Callon's analysis to the carbon market and essentially concludes that market construction will indeed fail: 'conditions are not cool enough for the spadework for commercial relations', and 'an unstoppable fount of complexity' has been uncorked (2005, pp. 211 and 229).

Indeed, much of what I have described is consistent with a bleak, essentialized view of capitalism, as inherently irresponsible and environmentally damaging, rather than Callon and Latour's more optimistic perspective. Yet the conclusion that carbon markets are inherently flawed carries a risk. Abandonment of such markets might well mean no serious international abatement efforts, rather than abatement by other means. If the Emissions Trading Scheme were abandoned, could the European Union find a viable alternative, and how long would it take? The political viability of a harmonized carbon tax, the obvious other route, remains questionable, because of the unanimity required.

Similarly, political constraints mean that if international agreement on a replacement for the Kyoto Protocol can be reached, it is likely to include something similar to the Clean Development Mechanism. The CDM is, as noted, a result of the need to secure developing-country participation in abatement efforts in a context in which the developing world was and is unwilling to take on caps: even caps postponed to a later date, given the risk that by then many of the cheaper opportunities for abatement might be exhausted. The reluctance is understandable, given the desire not to allow a problem caused by the industrialized countries to serve as a brake upon development, and it is likely to persist – even in a context in which China, in particular, no longer fits the traditional template of a developing country. Abatement efforts in the developing world are thus likely to continue to require funding from the developed world. Of course, such funding could be achieved by direct government aid – Wara (2007) points out that HFC-23 decomposition could have been achieved far more cheaply via this route than via the CDM – but that again raises the question of whether governments would in practice make the requisite large transfers of resources.[22]

To conclude that carbon markets must fail may also be unduly pessimistic, in that it would miss the extent to which carbon markets hitherto have been experimental, in the case of phase 1 of the European Union Emissions Trading Scheme, quite explicitly so: interviewees involved in establishing it reported the many compromises that had to be made to get it up and running, such as the fact that it was possible to challenge only the most egregiously over-generous national allocations of allowances. While existing carbon markets unquestionably have major flaws, those flaws are increasingly becoming manifest, and ways of remedying them are available. Thus, windfall profits within the European scheme could be eliminated by moving from free allocation to full auctioning (Dales's original proposal), and there is now a real possibility that this will happen from 2013 on, at least in the electricity sector.

If carbon markets are here to stay, can they be improved? One example of a successful intervention is of particular interest from the viewpoint of this paper, because it involves making things *not* the same. NGOs, especially the World Wildlife Fund, have sought to create a separate category of 'gold standard' CERs, covering only renewable energy and energy conservation projects, and excluding industrial gas projects such as HFC-23 decomposition.[23] The gold standard is a form of cooling in Callon's sense (as with the CDM as a whole, there is a formal methodology, automated tools, a role for auditors, and so on), and there are 'bottom-line' effects. Although from the viewpoint of the Kyoto Protocol or of monetisability via the European Emissions Trading Scheme, an ordinary and a gold standard CER are identical, my interviewees reported that the market price of the latter is now around 10-20 percent higher. (They suggest that the cause of the higher price is that those who are buying CERs not just for compliance but to achieve 'carbon neutrality' or

[22] For an intriguing suggestion of a means of achieving north-south transfers at a sufficient level to make a significant impact on developing countries' needs to adapt to climate change, see Müller and Hepburn (2006).

[23] See http://www.cdmgoldstandard.org, accessed 17 January 2008.

other forms of offsetting fear reputational risk if it is discovered that 'neutrality' is being achieved via industrial gas projects such as HFC-23.) 'Multiple monies' have emerged in the carbon market, as a result of intervention by activists.

The intervention by the World Wildlife Fund and other NGOs was informal: it did not alter the formal procedures of the CDM. However, NGOs are also seeking to practise a politics of market design in a more formal sense, seeking to alter rules and procedures. That, indeed, is precisely the course of action that Callon and Latour's perspective implies. If markets are plural – Callon's best-known work is titled *The Laws of the Markets* (Callon 1998) – and 'capitalism' has no unalterable essence, then this may indeed be productive.

Such efforts are too recent and too limited to know whether they will be successful. However, it is worth noting that changes in market design of a kind that seem potentially achievable could be consequential. Take the underlying issue of a carbon market versus a carbon tax. Many environmental activists prefer the latter, as do some economists such as Nordhaus (2007). Nordhaus argues that the classic analysis by Weitzman (1974) of the conditions that influence the relative efficiency of 'quantity-based' instruments (such as a cap-and-trade scheme) and 'price-based' instruments (such as a carbon tax) suggests, given the specific cost-benefit features of combating global warming, the superior efficiency of a carbon tax.

Yet carbon markets seem politically feasible, even in the US; carbon taxes may not be, even in Europe. Intriguingly, however, a cap-and-trade market, with full auctioning rather than free allocation, can be equivalent to an optimally set tax. In both, polluters pay, either by having to buy permits or by paying the carbon tax. Indeed, under admittedly 'idealized conditions' (Hepburn 2006, p. 229) they pay the same amounts, and the environmental outcomes are the same. Thus, if the relationship between emission levels and the carbon price is known with certainty, either a cap-and-trade market or a correctly set tax can achieve a required level of abatement, and the necessary tax rate will be the same as the allowance price. Of course, the relationship between emission levels and the carbon price is not known with certainty, and for that and other reasons the full equivalence between tradable permits and a tax does not pertain in the real world. However, economists' analyses suggest ways of designing a carbon market that might make it and a tax more closely equivalent in practice. These include rules facilitating the ‘banking’ of permits for future use and the ‘borrowing’ of permits from future years, regulated perhaps by an adjustable requirement for firms to hold a certain amount of permits in reserve, analogous to the adjustable reserves that banks are required to hold (Newell, Pizer and Zhang 2005).

Precisely because of the similarity of auctioning to a carbon tax, emissions markets seem almost always initially to involve free allocation, because this reduces lobbying against them and political opposition. However, once markets are well-established, as the European Union Emissions Trading Scheme now is, shifting to auctioning may become easier (especially now the ‘economic experiment’ of Phase I of the ETS has made publicly visible the problems that free allocation leads to). For example, in October 2007 Sweden announced that it was ending free allocation of allowances to its electricity and heat sectors.[24] Indeed, as noted above, it seems increasingly likely that in the third phase of the ETS, from 2013 onwards, auctioning may be much more heavily employed, at least for sectors such as electricity that cannot in practice easily move production outside of the European Union.

The effort to shift the ETS to auctioning is ‘politics’ of a classic, recognizable kind, involving governments, the policy makers of a supranational body, nation-state representatives, fierce industry lobbying against auctioning, and so on. Not all the politics of carbon markets, however, fit that recognizable template. Neither the IPCC nor the International Accounting Standards Board see themselves as political bodies, and indeed it is of particular importance that the former not be seen as political, despite the efforts of its critics to paint it as such. Yet they are arguably locales of ‘subpolitics’ in Beck’s sense: politics ‘outside and beyond the representative institutions of the political system of nation-states’ (Beck 1996, p. 18; see Holzer and Sørensen 2003). For example, the IFRIC and now the International Accounting Standards Board (which is turning its attention to emission rights) have to contend with pressure that has had the effect of blocking efforts to ‘make things the same’ in

[24] Announcement of Environment Minister Anders Calgren, reported by news service Point Carbon (www.pointcarbon.com), 11 October 2007.

carbon markets. In the case of the IPCC, the key 'subpolitical' matter is, paradoxically, preserving the boundary between 'science' and 'politics', since that boundary is precisely what is needed to facilitate political action, because it matters that action can be seen as based upon 'sound science'.

The subpolitics of carbon markets may seem esoteric, and it is certainly not simple, but it is important. Clearly, such markets are only one tool for combating global warming, and other tools are also important: direct regulation, carbon taxes (where these are feasible), greatly increased public expenditure on research and development and on necessary infrastructure (for example, the electricity grid changes needed to make increased renewables production more attractive economically), the removal of the many subsidies for fossil-fuel extraction and use, and so on (see, for example, Lohmann 2006 and Prins and Rayner 2007). Nevertheless, making carbon markets more effective is crucial, and the esoteric nature of their subpolitics means that researchers have a particularly salient role to play in bringing to light matters of apparent detail that in fact play critical roles in this respect.

It is this author's hope that this paper will encourage the work of this kind that is so badly needed. The existing and planned experiments in changing capitalism's bottom line are heterogeneous, widely diffused worldwide, and involve many aspects – scientific, technological, political, accounting, sociological, anthropological, geographical – beyond economics as narrowly conceived. The experiments need 'witnesses' (Shapin and Schaffer, 1985), and those witnesses must be multiple: lay as well as professional, from many countries, and if they are academics from many disciplines.[25] Carbon markets need to become part of a process of 'social learning' (qv Williams, Stewart and Slack 2005), in which institutions to mitigate climate change are created, evaluated and reshaped.[26] Such multiple witnessing and social

[25] I owe this way of formulating the matter to Andrew Barry.

[26] There is of course a trade-off between the need to evaluate and improve a market's design and the need for rules that are stable over reasonably long time periods. The European Union's trade-off seems reasonable – an explicitly experimental three-year initial phase, then a five-year second phase, followed by a third phase that is likely to last eight years (2013-20).

learning needs to concern not just the overall futures of carbon markets, but the crucial ‘nuts and bolts’ of their construction, questions such as how different carbon sources and sinks are commensurated, how allowances are treated in accounting terms, and many other such matters that I have been unable to discuss for space reasons. If this modest paper recruits others to take part in this multiple witnessing and social learning, then it will have achieved its goal.

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Figure 1: The interface of the gas corrector meter in the input pipe to Edinburgh University's central area combined heat and power plant. Photograph courtesy David Somervell, Estates and Buildings, University of Edinburgh.

Figure 2: Price history of allowances, phase I of European Union Emissions Trading Scheme. Courtesy Point Carbon.