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Finding the Ratchet: The Political Economy of Carbon Trading

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Universities contain rooms and buildings that academics never enter, such as boiler houses. Amongst their contents are meters, some of which at my university, Edinburgh, now have two roles: as well as determining our gas bills, they measure, indirectly, our emissions of carbon dioxide. The meters have become part of the European Union's Emissions Trading Scheme, and thus are part of a microcosm of what may become a worldwide carbon market.

One doesn't usually think of universities as big carbon-dioxide emitters – aside from in inevitable jokes about the generation of hot air – but the capacity at two of Edinburgh's three highly efficient combined heat and power centres pushes them over the 20 megawatt threshold of European emissions trading. Like other operators of combustion installations in the European Union of that size or larger, the university has in consequence to hold permits to emit carbon dioxide.

Edinburgh University receives an allocation of allowances, each permitting it to emit a tonne of carbon dioxide. If it were to emit more carbon dioxide than it has allowances, it would have to buy further permits on the carbon market, or else face a fine. If the university were to cut its carbon emissions below its level of allowances, it could sell the excess permits, thus earning income from its frugality. Such

purchases and sales take place via brokers and on a number of organised exchanges such as Nord Pool, the Nordic power exchange. If it chose, Edinburgh University could trade carbon futures – contracts that would oblige it to buy or to sell allowances at a set price on a given date. Those futures are now traded on the European Climate Exchange, using the electronic trading platform of London's International Petroleum Exchange.

Edinburgh University could also indulge in even more exotic trading. We could invest in a 'Clean Development Mechanism' project in the third world, and once the International Transaction Log that registers such transfers is up and running later this year, exchange certified emissions reductions from the project for European allowances. If California's carbon trading plans come to fruition, and a current study by its government and that of the UK were to lead to its emissions market being linked to that in Europe, we could buy or sell allowances in Los Angeles or San Francisco. If the blueprint in the UK Treasury's Stern Review is followed globally – a big if – we would before long be able to trade carbon anywhere in the world.

As John Lanchester noted in the 22 March issue of *LRB*, the science of global warming is not straightforward. The basic physics has been clear since the nineteenth century. What's been harder to understand in detail are matters such as the many feedback loops by which a rise in planetary temperature alters other processes (such as cloud formation) that in their turn also affect temperature, the extent to which smoke and emissions of sulphur and particulates (all of which reflect sunlight) are masking greenhouse-gas warming, and the likely behaviour of the great ice sheets of Antarctica and Greenland as temperatures rise.

While intensive, large-scale scientific research stretching back over thirty years and more has by no means eliminated all such uncertainties, its findings now point unequivocally to the conclusion that it would be dangerously irresponsible not to attempt to slow global warming. How best to do so has been a debate largely dominated so far by economists, such as Sir Nicholas Stern, the leader of last year's widely reported Treasury study.

Economists tend by inclination to be sceptical about either voluntary restraint or governments' capacity to find cost-effective ways of regulating emissions. The record so far suggests they may be right on the former. The profession in general is perhaps too pessimistic on a direct role for government, but it's certainly true that government intervention in the field of energy technology has at best had mixed results, as the chequered history of civil nuclear power demonstrates.

So economists have tended to support mechanisms that curb emissions by making them costly. As the Stern Review puts it, 'the first task of mitigation policy' is to make emissions of carbon dioxide and other greenhouse gases (which have up to now been 'free' from the viewpoint of the emitter) carry a price. A carbon tax could do that, but in recent years the dominant proposed mechanism – by-and-large the preference of the Stern Review, for example – has been 'cap and trade' schemes such as the one now in place in Europe.

In such schemes governments set a cap on emissions, sell or give that number of allowances to emitters, and then monitor emissions and fine anyone who emits

without the requisite allowances. If the monitoring and penalties are stringent enough, overall emissions are thus kept down to the level of the cap. Crucially, if trading works properly this happens in a cost-effective way. 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.

In 1968, the University of Toronto economist J.H. Dales first put forward in something like full-fledged form the idea of controlling emissions via a 'cap and trade' scheme. Emissions markets were implemented in relatively minor and sometimes ham-fisted ways in the 1970s and 1980s, mainly in the United States. It was only in the 1990s that the idea became mainstream.

The crucial development was the start of sulphur-dioxide trading in the US in 1995. 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 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. A particularly influential lobbyist for trading was the advocacy group Environmental Defense. One of its members of staff, the lawyer Joe Goffman, largely drafted Title IV of the Clean Air Act Amendments of 1990, which introduced sulphur-dioxide trading. Economists such as MIT's Richard Schmalensee and Robert Stavins of Harvard's Kennedy School also became involved directly. They didn't simply advocate a cap and trade scheme, but helped steer it to political acceptance.

What was agreed upon in the 1990 legislation differed from what economists might have wanted in two respects. First, there was no attempt at a cost-benefit analysis to determine the optimum level of reduction of sulphur-dioxide emissions – and in a sense fortunately so. Cost-benefit analyses of contentious issues tend simply to become mired in controversy, because they often pivot on factors that can only be estimated, not measured. (In analyses of global climate change, for example, the dominant factor is typically the choice of 'discount rate', which determines how costs and benefits at future times are translated into present-day values. There has already been fierce technical dispute over the Stern Review's choice of a low discount rate, and thus high present-day values.) A ten-million ton reduction in sulphur-dioxide emissions was roughly consistent with the science of acid rain, and it had the straightforward advantage of being a memorable round number. The economists involved in advocating the sulphur market just accepted it, rather than seeking to fine-tune it.

Second, when economists such as Dales proposed emissions trading they assumed that governments would sell the allowances in question. Instead, nearly all the sulphur allowances were given away free of charge to the utility companies that operated power stations, in amounts roughly (but, as discussed below, not exactly) proportional to the calorific value of the fuel they burned in the baseline years 1985-1987. 'Grandfathering' – as this way of proceeding is called – has disadvantages compared to an allowance auction. It entrenches incumbents, because of the cost advantage they then enjoy over newcomers who have to pay for their allowances. Indeed, if an industry can see 'grandfathering' coming, there's an incentive to increase a polluting activity in order to achieve a larger allocation. In respect to carbon, there are suspicions that new coal-fired power stations are currently being built in the US in part for this very reason.

Those who planned the sulphur-dioxide market realized, however, that there was no politically feasible alternative to the free distribution of allowances. Forcing utility companies to buy them would have generated a level of hostility from the industry that would have been fatal.

Free allocation meant enormously complex jostling over its rules. In the months leading up to the eventual signing of the bill by George H.W. Bush on 15 November 1990, there was intense lobbying for provisions that would favour mining and/or utility interests in particular states by introducing exceptions to the baseline allocation of 2.5 lb of sulphur dioxide per million British thermal units of input. Some

states, such as Florida, were able to win favourable allocations simply because they were expected to be finely balanced in that autumn's elections.

For some of the economists involved in the sulphur market, it was an education in the political process. Thus MIT's Richard Schmalensee (co-author of the main study of sulphur trading, Ellerman et al., *Markets for Clean Air*) recalled laughing when a special provision concerning lignite, the 'brown coal' common in North Dakota, was proposed at a meeting of Congressional staff members at which he was present. 'He was forcefully reminded that North Dakota was a relatively poor state with bleak prospects and, more important, that Chairman Burdick [Quentin Burdick, the octogenarian Democrat from North Dakota who chaired the Senate Committee on Environment and Public Works] was not to be trifled with.' The lignite provision duly became law.

Uncorrected, the need to buy off potential Congressional opposition with favourable allocations would have led to failure to achieve the ten-million ton reduction. When the implications of all the various rules such as the lignite provision were worked out (which was not a simple task), they added up to an over-allocation of allowances of around 10 per cent.

However, those lobbying for the legislation had cleverly inserted a correction mechanism early in the legislative process: 'the ratchet', as it became known. This was a rule that clawed back any aggregate over-allocation by imposing a corresponding uniform across-the-board cut in allowances. Once the more powerful special interests had successfully been bought off with what turned out to be the 10

per cent over-allocation, everyone's allocation was then reduced by roughly a tenth. The detailed calculations were made not by the House or the Senate, but by the Environmental Protection Agency, which imposed the ratchet months after the legislation was irrevocably on the statute books. The sheer complication of the process of working out what the rules implied for the sizes of allocations hampered opposition to the ratchet: participants seem to have assumed that it would cut their allocations by only around a twentieth.

While all the politicking indeed affected who got what, the ratchet thus kept the requisite overall cut in emissions more-or-less intact. Furthermore, the cut was then 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 reduce costs (by around a half, according to the analysis by Ellerman, Schmalensee and their colleagues) 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.

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 industrialized 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. A country with a Kyoto commitment can meet it by controlling emissions domestically. Alternatively, it can pay for reductions made via projects in developing countries without Kyoto targets (that Kyoto provision is the 'Clean Development Mechanism') or via projects in other industrialised countries (such 'Joint Implementation' projects are mainly to be found in the former Soviet bloc). Indeed, a nation-state signatory can simply pay another signatory for reductions the latter has made beyond its commitments. Because the Kyoto commitments of Russia and Ukraine did not take into account the collapse of heavy industry after the fall of communism, they may have a lot of essentially spurious 'reductions' to sell once their governments have met the requirements for international trading under Kyoto, such as the construction of national greenhouse-gas inventories.

The Kyoto Protocol was no more than the barest skeleton of a market, containing almost no detail on how this trading was to take place. The US had only just got its way. Much of the developing world was suspicious of international trading as likely 'carbon colonialism', fearing that the developed world would use it to escape its responsibilities. The European Union's preferred policy recipe had been a mixture of harmonised carbon taxes and co-ordinated government measures to promote low-carbon technologies. Notoriously, too, the US then walked away. In

March 2001, the Bush administration announced that the United States was withdrawing from the Kyoto Protocol.

By 2001, however, the idea of carbon trading had come into favour in Europe. In part prompted by lobbying by Environmental Defense, the US NGO that had been the crucial advocate of sulphur trading, British Petroleum had set up an internal carbon trading scheme between its business units. While no cash actually changed hands, the resultant management attention to emissions paid dividends. BP was able quickly to cut its emissions by its 10 per cent target, and even made money doing it: if you stop the unnecessary flaring and venting of gas, you have then more to sell.

Denmark launched a carbon market amongst its big electricity producers in 2001. The UK began an experimental, voluntary scheme in 2002. The landmark scheme, however, has been the European Union's carbon market, launched in January 2005.

What pushed Europe towards trading rather than the initially preferred carbon tax is 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. Hence the shift in allegiance to trading.

The design of the European trading scheme was deliberately simple. To date, it covers only carbon dioxide, not other greenhouse gases such as methane. In sulphur trading in the US, each smokestack is fitted with sophisticated automatic measurement devices. European carbon-dioxide emissions are measured less directly, using the method known as ‘mass balance’, in which for example gas-meter readings or invoiced quantities of coal or oil are multiplied by appropriate emission and oxidation factors. Only large, fixed installations are covered. Ground transport, shipping and aviation are all currently omitted, and the domestic sector is covered only indirectly via the participation of electricity suppliers. In consequence, no more than around half of Europe’s emissions currently fall within the scheme.

The European carbon market is nevertheless a remarkable achievement. It took the US five years from the passage of the requisite legislation in to the start of sulphur trading, while the European Union managed what was in many ways a more difficult task of market construction in three years. The number of big emitters of carbon dioxide is larger than that of big producers of sulphur dioxide, and the European Union has also been in the throes of wholesale expansion. The tricky technical stuff that too often undermines ambitious government programmes – such as constructing the central database and the national registries, and keeping track of the allocation of allowances to thousands of installations – has gone remarkably well, especially given the short timescale.

The trading of allowances seems to be going smoothly, with no serious technical disruptions even when the market is extremely busy. Measurement and independent verification, the foundation of any emissions market, is getting better. There were a lot of difficulties in the first year of the scheme caused simply by companies' unfamiliarity with what they had to do, but I'm told that the 2006 measurements, which currently are being collected and aggregated, are better in that respect.

Inconsistencies across Europe in how the measurement rules are interpreted remain a problem, and there is some room for 'gaming'. Installations can choose to use either the standard emission factor for a type of fuel, or a factor specific to the particular fuel they are using. If one burns coal with a carbon content higher than that assumed by the standard factor, while using that factor to calculate emissions, one can thereby deliberately underestimate one's emissions, perhaps by around 2 percent. It doesn't sound a lot, but aggregated over the scheme it could have a significant impact on the balance between the supply and demand for allowances.

Overall, though, such problems appear tractable. The most difficult issue has been the politics of allocation. In the first phase of the Emissions Trading Scheme (which runs from January 2005 to December 2007), Europe did not find its equivalent of sulphur's ratchet. As with sulphur, almost all carbon allowances have so far been given away, not auctioned. Again, the scheme's designers felt that this was the only politically feasible way to proceed, and in particular they feared that the similarity of

the revenue-generating aspect of an auction to a tax might drag the scheme back into the sphere of unanimity.

The amounts of the allowances that are distributed are governed by National Allocation Plans drawn up by each of the member states. Predictably, Europe's industries and most of its governments pressed for generous allowances. The European Commission rejected the most outrageous of the plans for the 2005-7 phase of the scheme, demanding a 25 per cent cut in Slovakia's plan and a 16.5 per cent cut in Poland's. However, smaller exaggerations of likely needs in the majority of national plans have added up to a scheme that in the current phase is in overall surplus.

Initially, the extent of over-allocation wasn't clear. As the price of gas rose relative to that of coal in 2005 and the early months of 2006, so did the price of the allowances needed to burn the latter: coal is much more carbon-intensive than gas. Market participants also had to worry about uncertainties such as weather: a serious cold snap should push the carbon price up, as should a prolonged dry spell (because it reduces hydroelectric capacity).

Europe's power sector was in general short of allowances, while the excess was concentrated in the hands of energy-intensive industry. The big power generators are experienced, active traders, who often sell electricity at prices fixed a year or so in advance and thus want to hedge the risk of big rises in the costs of their inputs, which now include carbon allowances. So they wanted to buy allowances, but industrial companies (often without an equivalent tradition of trading) were slow to sell,

preferring to wait and see the extent to which their emissions fell short of their allocation.

The resultant temporary imbalance of supply and demand caused prices to rise markedly from January 2005 to March 2006, peaking at €31/tonne, a level that, if it had been sustained, would probably have been a sufficient incentive to encourage real emissions reductions (such as electricity suppliers switching from coal to gas). In April and May 2006, however, the news gradually leaked out that in 2005 the industries and power generators of most of Europe's member states had produced less carbon dioxide than their national allocations of allowances. On 26 April, the European carbon price fell 30 per cent, and by mid-May allowances were trading as low as €9. As the fact of over-allocation sunk in, prices sunk almost to zero: in early 2007, one can buy the right to emit a tonne of carbon dioxide for as little as €1.

There's a sense in which the first phase of the European Emissions Trading Scheme was always meant as an experiment rather than as a tool of substantial emissions reductions. The second phase, which will run from January 2008 to the end of the Kyoto commitment period in December 2012, is going to be much more significant. The European Commission sees the need to ensure the credibility of what is in many ways its flagship policy. It also now has much better emissions data to use to evaluate National Allocation Plans, and the fact that the second phase of trading coincides with the Kyoto commitment period means there's a clear benchmark against which to assess the plans of all the countries that are in danger of not meeting their Kyoto commitments. So this time round the Commission has been able to be significantly tougher in its assessments. Once again almost all member states have

sought over-generous allocations, but this time their wishes haven't been granted: so far, all the plans except that of the United Kingdom have been cut back.

Overall, there's almost certainly going to be a shortage of allowances in 2008-12. However, that may not translate into a major need for abatement by European industry, because large numbers of certified emissions reductions from Clean Development Mechanism projects (and smaller numbers of 'emission reduction units' from Joint Implementation projects) will be available to be converted into European allowances. Indeed, Point Carbon, the leading carbon-market consultancy, estimates that the entire shortfall of allowances can be made up this way.

There's nothing wrong in principle with the idea of the Clean Development Mechanism: that companies and government agencies in industrialised countries should receive carbon credits in return for providing the capital for 'green' projects in the third world. Many such projects indeed seem very worthwhile, and unequivocally to be welcomed. As with all emissions trading, however, it's the nuts and bolts of the Clean Development Mechanism that matter: for example, the rules that govern which projects earn credits. As the Stern Review notes, almost a third of the credits 'in the pipeline' come from 15 big projects to stop the generation of gases like HFC-23 (trifluoromethane) from industrial production in China.

That needs done: HFC-23 is around 12,000 times as potent a greenhouse gas as carbon dioxide, kilogram for kilogram. It's generated mainly as a by-product of the production of a substance called HCFC-22, which is used chiefly as a refrigerant. HCFC-22 itself contributes to global warming (albeit not as much as HFC-23), and it

depletes the ozone layer, although it isn't amongst the most damaging such chemicals. You can eliminate HFC-23 from the waste gases of a plant producing HCFC-22 by burning those gases at very high temperatures. The process is tricky – get it wrong, and you produce dioxins – but it's well within the scope of existing technology and relatively cheap.

Under the Montreal Protocol governing ozone-depleting substances, HCFC-22 will eventually have to be replaced by environmentally-superior hydrocarbon and ammonia-based refrigerants. However, there's deep concern that the way in which HCFC-22 plants can earn money from the Clean Development Mechanism by eliminating HFC-23 could slow the phase-out – indeed that it risks providing a perverse incentive to build new plants producing HCFC-22. There's currently sharp debate over whether any, or how many, such new plants should be eligible for credits for destroying HFC-23.

Such difficulties have not killed the idea of carbon trading. After all, one could argue that by focusing attention first on the things that are cheapest, such as eliminating HFC-23, the market is simply doing what markets do. There's anecdotal evidence from those I've spoken to of the beginning of the emergence of a two-layer market, in which credits from more recognisably green development projects such as renewable energy earn higher prices than those from industrial-gas projects such as HFC-23 elimination.

Above all, emissions markets gain their political force from their capacity to create alliances between 'left-wing' environmentalism and 'right-wing' pro-market

sentiment, and to attract business leaders such as BP's John Browne. The example of the BP scheme, and eloquent advocacy of carbon trading by BP staff were influential in laying the political groundwork for the European carbon market.

In particular, carbon trading is now building cross-party momentum and gaining significant industry backing in the US, and not just in California. In December 2005, for example, seven states in the northeast of the US announced that they planned to begin regional trading of carbon from their electric-power sectors in 2009. Indeed, by September 2006 Washington DC reminded John Carey of *Business Week* of the same city twenty years previously. Then too a Republican administration with a poor environmental record was entering its final years, thoughts were turning to the future, and the political groundwork was beginning that turned into bipartisan support for sulphur trading and eventual legislation under a new presidency.

There are multiple climate-change bills before Congress, the most high-profile of which is co-authored by a leading contender to win the Republican nomination in 2008, Arizona senator John McCain. Its sponsors include both of the most high-profile Democrat candidates, Hillary Clinton and Barack Obama. Although capping carbon has been an idea more strongly welcomed by Democrats, Republican strategists will have noted that the announcement of the Californian scheme gave Governor Schwarzenegger's poll ratings a healthy boost, helping him do better in November's elections than many of his fellow Republicans. Large sectors of industry in the US would much prefer a nation-wide carbon market with uniform, stable rules to a patchwork of incompatible, unpredictable state-level markets, so it's not

impossible that a new President prepared to lead on the issue would be supported by significant sectors of US industry.

Nevertheless, many people, especially on the political left, have an instinctive dislike of the idea of emissions trading. Amongst its roots is a variant of what the economic sociologist Viviana Zelizer calls the 'hostile worlds' doctrine. She's concerned with the worlds of economic relations and of intimacy. There, the 'hostile worlds' doctrine is that the intrusion of economic considerations corrupts intimacy, and conversely that kinship and other intimate relations need to be stopped from corrupting what should be impersonal economic transactions.

Zelizer questions whether the hostile worlds doctrine is right: for example, is paid care of children or of the elderly necessarily inferior to that provided by kin? Is your relationship to your children really damaged by paying them to Hoover the house or clean the windows?

In my view, Zelizer's open-mindedness should also be applied to emissions trading. Just as economic relations and intimacy aren't necessarily at odds, we shouldn't assume a priori that market pricing is detrimental to environmental stewardship. Capitalism, after all, has proved itself rather good at economising on inputs that carry a price, such as labour. If carbon-dioxide emissions carried a significant price – €30 per tonne, say – that was expected to rise over the long term, we could expect real efforts to reduce emissions. Indeed, there's already tentative evidence from Point Carbon surveys that corporate abatement efforts in Europe, little in evidence a year ago, are beginning.

So the issue may be less the intrinsic merits or flaws of the idea of emissions trading than the critical details that determine whether such markets are environmentally beneficial (as the sulphur market largely has been) or complicated ways of achieving very little. The European Union's unilateral commitment to reduce its emissions to 20 percent below their 1990 level by 2020 (whatever the rest of the world does) is a hugely encouraging move in this respect. By providing a simple, high-visibility target for reductions – one that will be increased to 30 percent if the rest of the world also takes action – it could set the scene for an equivalent of the ratchet in European carbon market from 2013 onward: a tough, centralised allocation that can't be met only by importing credits from elsewhere, and that would force real abatement.

Of course, what happens in Europe will have only a very limited impact on global emissions unless the US, China, and the world's other large emitters also begin significant abatement. Whether there will be an international agreement to replace the Kyoto Protocol, and if so what form it will take, remain profoundly unclear: serious negotiations are only just beginning, and progress will probably not be fast until after the US Presidential elections.

Almost certainly, though, if there is such an international agreement carbon trading will be at its heart. That will again raise the issue of the ratchet, of the need for a mechanism to stop a carbon market failing because the caps haven't been set tight enough. Finding such a mechanism has been hard enough even in a partially unified polity such as Europe; it will be much harder globally. Furthermore, even if

the world can find its ratchet, carbon trading shouldn't be expected on in its own to solve the huge problem humanity faces in curbing emissions. Global efforts to do that are in their infancy, and it would be folly to neglect the other policy measures that could help, such as direct government regulation (a small but important example is the phasing out of old-fashioned inefficient light bulbs), massively increased research and development spending, and a well-thought-out policy for tackling the many practical obstacles to the uptake of energy saving measures and of the cleaner technologies that already exist.

Taxes, currently much less fashionable than trading, also have a role to play. Take aviation, for example. It seems likely to be brought into the Emissions Trading Scheme in 2011-12, but it's quite possible that phase-two allowance prices will be no more than €15 per tonne, which would translate into very modest increases in fares, ranging perhaps from as little as €2 for short flights to around €20 for long-haul return flights. Aviation's overall climatic impact – its 'total radiative forcing' – is reckoned to be of the order of two to five times that of its carbon-dioxide output alone (which is all that would be covered by current European Commission proposals), because of the role of emissions of nitrogen oxides, the formation of condensation trails and the enhancement of cirrus clouds. There's a strong case for using taxation to take those other effects into account. A good place to begin would be to end the anomalous situation in which aviation enjoys an advantage over other modes of transport because its fuel is not taxed.

Needless to say, such matters are intensely political. The European Commission officials who played the central role in constructing the new carbon

market are intelligent and dedicated, and at the moment they enjoy a remarkable level of support from leading governments. But that support can't be guaranteed to continue. Europe's NGOs (not just the obvious ones such as Greenpeace and Friends of the Earth, but others such as the World Wildlife Fund) have played, and continue to play, a relatively unpublicised but important role in encouraging the tightening of the ratchet. But the NGOs are underfunded and easily outgunned by industry lobbyists. So there's much for political activists to do, and the relatively esoteric nature of carbon-market politics means that small numbers of well-informed people can have a real effect.

There's also much for my fellow academics to do. To date, research on carbon markets has almost exclusively been the province of economists, and generally it hasn't fully tackled the messy, highly politicised, material reality of such markets. So economic sociologists and political scientists are needed too, as are anthropologists and other area specialists who can help us understand the complex impacts of the Clean Development Mechanism's incentives in countries such as Brazil, China and India. We can't just take it for granted that all such projects are genuinely beneficial, and the rules of the mechanism need constant monitoring to ensure that perverse incentives aren't inadvertently being created. In short, colleagues, we've got to get inside the boiler houses, our own and the world's.