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Credible Carbon Policy

DIETER HELM, CAMERON HEPBURN, AND RICHARD MASH*

1. Introduction

Most developed countries have adopted targets for the reduction of carbon-dioxide (CO_2) emissions. Some of these are aspirational, some are recorded in voluntary international agreements, others have the force of law and are enshrined in national legislation. That CO_2 emissions should be reduced is now largely accepted: how such reductions might be achieved is still a matter of controversy and debate.

The case for using market-based instruments is well known and increasingly accepted by government.[1] The instruments under active consideration are emissions-trading schemes and carbon taxes. The former focuses on quantities—which are the variables that lend themselves to international agreements;[2] the latter on price—lending themselves to revenue raising.[3]

Such instruments are typically effective in the medium to longer term. In the short run, demand for carbon-creating activities, such as electricity generation and transport, tends to be inelastic, and supply tends to be linked to fixed, sunk, and lumpy capital stocks. To reduce carbon emissions requires both adjustments on the demand side and in non-carbon supply technologies.

* New College, Oxford, St Hugh's College, Oxford, and New College, Oxford, respectively.

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[1] Marshall Task Force (1998), HM Treasury (2002*a*, 2003*a*).

[2] The experience of OPEC, which switched from price to quantities at the end of the 1980s, provides evidence of this. Moreover, oligopoly theory shows that firms should collude on quantities when their goods are substitutes (see Singh and Vives, 1984).

[3] See, for example, Tietenberg (1990) and McKibbin and Wilcoxen (2002).

The credibility of emissions-trading schemes and carbon taxes is an important factor in their success or failure. Reducing emissions is likely to require significant irreversible investment from the private sector. The profitability of such carbon-reducing investments is highly sensitive to carbon policy. Whether firms invest will depend upon whether they believe the government can be taken at its word. Faced with the political demands of elections, will the government renege on promises to tax carbon in the future at pre-specified levels? Or, in the case of emissions trading, will governments and regulators rigorously enforce property rights and keep to promises about the number of permits available in the future?[4]

The private sector has good grounds for scepticism. Credibility from governments is a rare commodity for the very good reasons that politicians have multiple objectives and parties alternate in government. It is not surprising that there is a history of past default. Governments can (and do) 'change the rules' in a way that the private sector cannot.

A credible carbon policy must overcome two hurdles. First, clear rules must be defined for the resolution of trade-offs between conflicting objectives. Second, and more importantly, the government must convince firms that it will not renege on its promises once investment costs are sunk. Yet it is clear that there is an *ex-post* incentive to renege; the government faces a classic 'time-inconsistency' problem. A credible carbon policy is one which solves this time-inconsistency problem and provides firms with a degree of security that promises will be met.

Fortunately, the problems of credibility and uncertainty are generic, rather than specific to carbon policy, and have been particularly well researched in the area of monetary policy. The lessons that have been learned from the setting of monetary targets and interest rates are very helpful in thinking about carbon policy, and this paper carries these insights over into the carbon arena. We propose that the time-inconsistency problem in carbon policy can be solved through delegation to an independent agency. In addition to solving the time-inconsistency problem, delegation has two further benefits. First, it reduces uncertainty and political and regulatory risk, which is typically hard to diversify, thereby reducing the cost of capital. Second, it reduces the possibility that governments, which are driven by the next election and other short-term political economy considerations, will set carbon policy inappropriately.

The paper is structured as follows: the next section (section 2) sets out the credibility problem in carbon policy, the sources of non-

[4] Since the social cost of carbon is likely to rise over time, the policy will require appropriate adjustment over time (see Mendelsohn, 2003).

credibility, and the costs of failing to address it explicitly. There then follows a review of the time-inconsistency problem, and the outline of a conceptual framework (section 3). A plausible 'solution' requires an institutional context, and the design of an energy/carbon agency is sketched (section 4). A number of conclusions for the policy design are then drawn (section 5).

2. The Credibility Problem and the Low-carbon Strategy

(a) *Conflicting Objectives*

The British government set out its carbon policy in a White Paper, *Our Energy Future: Creating a Low Carbon Economy*, in February 2003 (DTI, 2003*a*). The central objective is a 60 per cent reduction in CO_2 emissions from the current level by 2050. This overarching target was recommended by the report of the Royal Commission on Environmental Pollution (RCEP, 2000) and augments two pre-existing carbon targets—the Kyoto objective of reducing a bundle of greenhouse gases by 12.5 per cent over the period 2008–12 and the 1997 Labour Manifesto target of a 20 per cent reduction in CO_2 by 2010 from the 1990 level (see UNFCCC, 1997; Labour Party, 1997).

To achieve the 2050 target, the White Paper has proposed three main policy initiatives—for renewables, energy efficiency, and emissions trading. These augment a host of other existing policies such as the Climate Change Levy and associated agreements.[5] Although there was intense lobbying in the build-up to the 2003 White Paper by the renewables and energy-efficiency interests, the government declined to set binding targets for 2020 for the contribution from each of these sources, leaving in place the existing target for renewables to contribute 10 per cent of electricity generation by 2010, and setting only aspirational 20 per cent targets for both renewables and energy efficiency for 2020. On emissions trading, the UK system has had, at best, limited success so far,[6] and future success depends upon the EU-wide scheme proposals, due to come into force in 2005 (see CEC, 2001, 2002).

This plethora of targets and policies presents the private sector with considerable difficulties in investment appraisal of carbon-free projects. It has to calculate the carbon-free benefits which may arise by weighing up its expectations on a host of targets and schemes, and try to predict

[5] Other policies include the Energy Efficiency Commitment and the Fuel Poverty Strategy (see Defra, 2001*b*; DTI, 2001).

[6] See, for example, ENDS (2002*a*,*b*, 2003).

how future governments will react to new information on actual emissions (the feedback rules), the evidence on the science of climate change, and, most importantly, how governments will react to perceived public opinion and voting behaviour.

This calculation is informed by the government's statements of objectives and the scope for *ex-post* revisions to policies. On the objectives, there have been a variety of relevant statements. The overarching objective is set as 'sustainable development', which is broken down into four components: social progress, environmental protection, prudent use of natural resources, and the maintenance of economic growth (DETR, 1999).

These components can obviously conflict, and it is apparent that specific carbon-reduction policies can conflict with social and economic growth objectives. No trade-off rules have been defined and, indeed, the plasticity of the definition of sustainable development is politically very attractive. A wide range of outcomes can be presented as 'successful'.

In the energy sector, the trade-off problems of objectives are explicit. In the PIU (2002) report, the Prime Minister's Foreword states that the objectives are, 'securing cheap, reliable and sustainable sources of energy supply'. This was further refined in the 2003 White Paper as: 'the four pillars of the environment, energy reliability, affordable energy for the poorest, and competitive markets for our businesses, industries and households'.

This ambiguity has been integrated directly into policy. The Renewables Obligation placed upon energy suppliers to purchase 10 per cent of their supplies from renewables by 2010 has a buy-out price, intended to put a cap on price effects.[7] The more general competition-policy priority focuses on the impact of energy policy on economic growth, with the DTI also having an explicit Public Service Agreement (PSA) with the Treasury. The DTI must:

> Ensure that UK ranks in the top three most competitive energy markets in the EU and G7 in each year, whilst on course to maintain energy security, to achieve fuel poverty objectives; and improve the environment and the sustainable use of natural resources. (HM Treasury, 2002*b*)

This replaces an earlier PSA target which explicitly focused on prices and international price comparisons. Finally, the DTI is only one of the departments involved in carbon policy: Defra has its own climate-

[7] See DTI (2002). Roberts and Spence (1976) set out the classic argument for hybrid quantity and price regulation.

change remit, especially in respect of energy efficiency (Defra, 2001*b*); and the Treasury sets tax policy.

The problem of conflicting objectives in the energy sector has been institutionalized in the relationship between the DTI and Ofgem, the energy regulatory body. Whereas the DTI set the objectives in the 2003 White Paper, much of the implementation is left to Ofgem, whose primary statutory duty following the 2000 Utilities Act is to protect the interests of customers (rather than achieve the CO_2 target). Ofgem has particular responsibility for setting prices for the monopoly networks, and in doing so must take a view about the required level of capital expenditure. The development of renewables is reliant on network investment to facilitate small-scale embedded generation and its cost allocation. Given that Ofgem does not have a primary duty to promote renewables (or energy efficiency), the government issued it with 'guidance', and this guidance includes having regard to renewables and energy-efficiency policies. Taking account of such guidance is, however, a *secondary* duty and hence does not necessarily result in implementation.[8]

Though the interfaces between the DTI, Defra, and Ofgem may seem a matter of detail, it turns out that such institutionalization of the conflict of objectives has considerable consequences, and we shall argue later that institutional reform is an integral part of addressing the credibility problem.

(b) *Non-credible Policies*

Investors in low-carbon technologies and energy efficiency have plenty of examples of non-credible behaviour by government to draw upon. Particular examples include the so-called *Climate Change Levy* (CCL), which came into force on 1 April 2001, as a result of the Marshall Report (November 1998); the *UK Emissions Trading Scheme* (UKETS), which commenced on 1 April 2002; and the *Guidance* issued to the energy regulatory body, Ofgem, discussed above.

The CCL was designed with an explicit intention to address the domestic and international CO_2 and greenhouse-gas targets. Lord Marshall was tasked by the incoming Labour government with comparing the relative merits of a tax or permits solution. The economic merits of each are well documented,[9] and if the policy was designed to achieve the targets at minimum cost, then *either* a carbon tax with *ex-post*

[8] Revised draft guidance (DTI, 2003*d*) was issued after the White Paper, incorporating the White Paper objectives (DTI, 2003*a*).

[9] See, for example, Kolstad (2000, chs 9 and 10) and papers cited therein.

adjustments to attain the target, *or* a carbon permits scheme would have been appropriate.[10]

The *political* merits of taxes and permits are less well documented, and the government decided in the light of the Marshall Report to implement an energy tax (the CCL) *and* to develop an emissions trading scheme. The energy tax was designed to avoid adverse effects on the coal industry (which was being supported in the 1998 White Paper, *Energy Sources*; see Helm, 2003*a*, pp. 302–3); and the UK emissions trading scheme excluded the electricity generators, again to protect coal. To further placate large industrial customers, exemptions of up to 80 per cent from the CCL were permitted under 'climate change agreements' (see Defra, 2001*a*). Finally, to avoid imposing an explicit burden on domestic customers, the CCL was, for political reasons, confined to the business sector. (The *economic* incidence of the tax did not, of course, avoid domestic customers, given the inelastic characteristics of short-run energy production.) Thus, the CCL and the UKETS were designed with an eye to the political interests of the coal and electricity industries, large-scale industry, and domestic customers.

To these specific examples, the 2003 White Paper adds a further dimension of non-credibility to investors in non-carbon activities. The White Paper had a political balancing act to achieve, in that it had to combine what seemed like a very demanding target for CO_2 reduction with more immediate-term aims of avoiding price or tax shocks to voters and limiting the public-expenditure implications.

This balancing act was recognized by many of the lobby groups involved in the White Paper's development. The renewables and energy-efficiency lobbies were keen to ensure that the White Paper contained binding targets for 2020, which electricity suppliers would be required to achieve (see EST, 2002; Solar Century, 2003). With legally binding targets imposed upon suppliers, investors in renewables and energy efficiency would be able to write long-term contracts with suppliers to enable the latter to fulfil their obligations. Such a scheme already existed for renewables up to 2010 (subject to a buy-out price—see Helm, 2002). The contracts would then reduce the cost of capital.

To achieve binding targets for 2020, the various lobby groups argued that the costs would not be great—hence assuaging the fears of politicians. The DTI persuaded itself of this convenient proposition, through a modelling exercise called MARKAL. MARKAL is a bottom-up approach to calculating least-cost solutions to meeting electricity

[10] Pizer (2002) suggests that, given uncertainty, a carbon tax is more efficient than carbon permits, although a hybrid policy is better still. His results, however, rest upon the assumption of a relatively flat marginal damage curve.

demand. The DTI's utilization of this model (DTI, 2003*b*) required certain assumptions about the costs of renewables and energy efficiency. It ignored the additional costs to the network and the back-up power supplies to wind generation (with a load factor of typically around 35 per cent) in the case of renewables, and also ignored the 'barriers' and transactions costs to energy-efficiency measures. It assumed that the costs of these technologies would be low, and falling over time. The model then integrated these assumptions to produce the prediction that the cost of achieving the 2050 target of 60 per cent reduction in CO_2 would be negligible—around 0.1 per cent of GDP per annum and between 0.5 and 2 per cent of GDP over the whole period (see DTI, 2003*a*, p. 9, para. 1.12).

The main implication was that since the costs of the new technologies were low, the level of support needed would also be low—and a very low priority in public-expenditure terms. If, however, as many private-sector investors might believe, the costs turned out to be high, investors might not be able to rely on future political commitment to support the overarching target, precisely because the government accepted the target on the condition that voters would not have much of a burden to bear.

There is, then, a substantial credibility problem in UK carbon policy. There are multiple objectives, and highly optimistic assumptions about costs. The unwillingness to face up to higher prices means that promises about future carbon policy are unlikely to be believed. Investors with sunk costs are aware that they risk *ex-post* opportunism by governments who lower future prices. This is likely to result in a failure to invest in low-carbon technologies and a higher cost of capital, raising the overall cost of achieving the CO_2 objectives. It is a problem which is unlikely to be confined to the UK.

3. Modelling the Credibility Problem

Credibility is a generic problem in many regulatory contexts. The area in the economics literature where it has probably been most extensively explored is monetary policy. Given a monetary or inflation target, how can policy-makers condition market expectations to believe that the monetary authority will not renege *ex post*, given that there may be short-term incentives to reduce interest rates? How do governments convince the public that there will be no U-turn? If market expectations are so conditioned, people will act as if wage- and price-setting targets are credible, thereby helping to fulfil the targets at lower interest rates.

If, however, the policies lack credibility, expectations built into wage- and price-setting processes may mean that the targets will be missed.[11]

This credibility problem is essentially a problem of 'time inconsistency'. Its key characteristic is a sequence of decision making whereby private-sector agents make an irreversible decision before the policy-maker acts. Private-sector agents look ahead to what the policy-maker will do, but their action is already fixed when the policy-maker makes the choice. Time inconsistency refers to the fact that the policy-maker with conflicting objectives has different incentives before and after the decision taken by private-sector agents. The result is that a policy-maker with 'discretion' will act differently to a policy-maker who can commit to the action in advance. Many situations where time inconsistency occurs are effectively repeated games involving uncertainty, but neither characteristic is essential.

Several 'solutions' to the time-inconsistency problem are found in different domains. Odysseus had himself bound to the mast *ex ante* to protect himself from the *ex-post* lure of the Sirens. In monetary policy, delegation to an independent central bank is the conventional solution. Patent law provides a further example. *Ex-post* prices might be lower, and welfare higher, if innovations could be copied and produced by competing firms. *Ex ante*, however, an incentive for innovation is needed, which is provided by the limited monopoly rights granted by patents.[12]

In Helm *et al*. (2003) we set out a formal model of time inconsistency in environmental policy. Time inconsistency arises from the sequencing of decisions. First, firms invest (irreversibly), having chosen from a spectrum of technologies with different emissions per unit of energy (such as coal-fired power stations or wind farms). Second, the policy-maker chooses the carbon tax that will apply during the productive life of that capacity.

The model is built with four main simplifying elements: (i) a constant elasticity demand curve for energy; (ii) a 'technology frontier', describing the trade-off between cleaner technology and lower production costs; (iii) constant emissions per unit of energy for a given technology; and (iv) Cournot competition with free entry, such that prices reflect average costs. The model also assumes that there is full information and, for the time being, the policy-maker acts on the correct preferences of society as a whole.

[11] The classic early references are Kydland and Prescott (1977) and Barro and Gordon (1983). For a survey see Blackburn and Christensen (1989). For textbook treatments see Walsh (2003) or Romer (1996).

[12] For a recent study on optimal patent life see, for example, Denicolò (1996).

The social welfare function has three components;[13] (i) consumer surplus from energy, which falls with the price-raising effects of carbon taxes; (ii) tax revenue received by government; and (iii) damage from emissions (E), represented by E^g with $g > 1$. The model generates three possible cases, depending upon different parameter values. In the first case, the tax rate under discretion is lower than under commitment; there is an *ex-post* incentive to reduce the tax once firms have sunk their investment costs. In the second, the *ex-post* incentive is to increase the tax rate. In the third, the tax rates before and after private-sector investment are the same.

There are at least three considerations that determine which case applies. The first concerns the elasticity of the tax base. Because taxation is distortionary in practice, the marginal cost of public funds is generally slightly above one.[14] One unit of revenue from an environmental tax is therefore valued at more than one unit of consumer surplus because it allows other distortionary taxes to be reduced.[15] If the elasticity of the environmental tax base is lower than other taxes, environmental taxation is an even more attractive source of revenue.[16] Marsiliani and Renström (2000) exploit this feature in their model of time-inconsistent taxation—there, the policy-maker has an incentive to *increase* the tax *ex post* relative to its optimal level because irreversible investment reduces the tax-base elasticity. Their model, then, is one in which carbon tax rates under discretion are higher than under commitment.

Second, if the environmental tax is regressive, as is typically assumed, and the government cares about distribution, then taxation entails additional welfare costs.[17] In this case, the tax rate under discretion will be lower than under commitment. Indeed, Abrego and Perroni (2002) propose a model of time-inconsistent taxation where distributional effects imply that the policy-maker has an *ex-post* incentive to *reduce* the tax.

[13] Profits are not included in the welfare function; they are zero in a model of Cournot competition with free entry.

[14] See Pigou (1947), Harberger (1964), and Browning (1976, 1987). For a review of the literature on the marginal cost of public funds, see Ballard and Fullerton (1992).

[15] This corresponds to the 'weak form' of the double-dividend hypothesis. For a definition of the 'weak' and 'strong' forms of the hypothesis, see Goulder (1995).

[16] This essentially amounts to the 'strong form' of the double-dividend hypothesis, in which it would make sense to replace other taxes with the environmental tax, even in the absence of environmental improvement. Many economists reject the strong form: see, for example, Bovenberg and Goulder (1996), Parry (1995), and Bovenberg and van der Ploeg (1994).

[17] Note, however, that work by Poterba (1989, 1991) and Metcalf (1999), among others, suggests that environmental taxes are not as regressive as typically thought.

Third, if the tax impairs the competitiveness of an export sector earning rents from imperfect competition, then there is an incentive to reduce the tax after investment has taken place, in order to support the competitiveness of the export sector. It is questionable, however, whether this effect would be of particular importance in the case of a British energy tax.

While the net effect of these three considerations is unclear, our model suggests that time inconsistency is likely to occur. Moreover, when distributional and competitiveness considerations outweigh the possible benefits of an *ex-post* reduction in tax-base elasticity, the government faces an *ex-post* incentive to reduce the tax rate. This generates the credibility problem for the British energy sector and the associated welfare costs.

A solution to the time-inconsistency problem is needed. There are four available options which could solve this problem in carbon policy, namely to:

- reduce the number of objectives;
- increase the number of instruments (including hypothecation);
- delegate to an international body within a contractual framework; or
- delegate to a national body within a contractual framework.

In an 'ideal' world, the solution would be some combination of the first two options. The government could focus on one core objective—CO_2—and relinquish the other aspects of the sustainable-development objective and/or it could use other instruments to address the social and economic growth components. The former is, however, practically impossible: it is highly implausible to imagine that a government could be democratically elected with a welfare function excluding social and economic-performance objectives. The second is more plausible: other policy instruments, such as social security policies, competition policies, and infrastructure and other market-failure interventions can be and are utilized alongside environmental-policy instruments. But yet again, there is no evidence that governments would be prepared to make the necessary adjustments to the other instruments to accommodate policies such as the carbon tax or emissions trading. The reasons are complex, political, and organizational. Objectives and policy instruments are delegated to departments of government, and the determination of each is subject to the bureaucratic and political processes. Each department has its own interests and priorities and budget considerations, and the history of departmental conflicts (in particular in this context between the DTI, Defra, and the Treasury) is well documented. Given that these reasons rule out the ideal solution, delegation to

another authority may be a better option for resolving the time-inconsistency problem.

The case for delegation is strengthened by the fact that, in addition to solving the time-inconsistency problem, it provides two further benefits. First, it provides transparency of policy actions and greater predictability, especially if it prevents government changing the objectives at will. Delegation would therefore reduce uncertainty and lower the political- and regulatory-risk components of the cost of capital. As this political risk is typically hard to diversify, reducing it would increase willingness to invest in low-carbon technologies. Second, delegation prevents governments, who are driven by the next election and other short-term political economy considerations, from setting carbon policy opportunistically.

These three arguments for delegation—the solution of the time-inconsistency problem, the reduction of uncertainty and political risk, and the avoidance of political bias—make a compelling case. Several general forms of delegation suggest themselves:

(i) The agency could be asked to maximize the social welfare function, provided that it is able to develop and retain a good reputation. Concern for its reputation would provide it with an incentive to implement the commitment outcome, despite short-term gains from reneging. The underlying argument is that because the agency is a long-lived institution not subject to short-term political pressures, it will be better able to develop and retain a reputation than governments.

(ii) If reputation alone will not ensure the optimal outcome, the agency could be given a single objective (the optimal level of emissions) to achieve, twinned with an appropriate policy instrument (the carbon tax rate, the number of emissions permits, or a hybrid instrument).

(iii) The agency could be constituted so that it maximizes a welfare function with a higher weight placed on emissions, such that its discretionary outcome corresponds to the social optimum.

Each of (i)–(iii) can achieve the social optimum. Each requires the agency to act with a high degree of transparency. Of the three, (ii) is the most readily monitored, but perhaps also the least flexible. Furthermore, we have experience of (ii) from the monetary policy example.

In the monetary policy case, the institutional response has been delegation to the Bank of England and its Monetary Policy Committee

(MPC). There are three potential reasons for delegation. First, as in (i) above, reputation may be stronger in a long-lived institution such as an independent central bank, rather than government. Second, as in (ii) above, an independent central bank may be given a single objective (inflation) as a sole or at least higher-priority target than other components of the social welfare function, such as output. This corresponds to inflation targeting, widely practised by many central banks including the Bank of England, where the inflation target is paramount though the regime can allow for some concern for output as long as there is no threat to the medium- to long-run inflation target.[18] Third, as in (iii) above, delegation to a central banker with a different welfare function, or different parameters within it, can solve the problem. The classic example is Rogoff's (1985) conservative central banker.

Even without time-inconsistency problems in monetary policy, there are still potential benefits from an independent central bank that have analogies in the carbon-policy context. First, there may be political bias in governmental discretion, either because governments target output above the natural rate for political reasons (see Bean, 1998) or through political business-cycle effects (see Drazen, 2000). In these cases an independent central bank may be beneficial simply because it can pursue social objectives largely free from political interference. Second, there are benefits from transparency of objectives and policy processes as a way of anchoring expectations.[19]

Hence monetary-policy delegation and carbon-policy delegation have a number of factors in common. In both cases there is a possible but not inevitable time-inconsistency problem. An independent agency may overcome the problem through enhanced reputation; a single objective that corresponds to the social outcome; or by maximizing a modified welfare function. With or without time-inconsistency problems, there may be large benefits from the avoidance of political bias and the increased transparency and stability of the regime through the anchoring of expectations.

For completeness, two differences should also be highlighted. First, most current monetary policy models have the property that there is no long-run trade-off between inflation and output or unemployment. The task of the central bank is to balance the short- to medium-run trade-off between these variables. In contrast, in environmental policy, the trade-off between energy prices and emissions is long term. Second, the expectations involved in price- or wage-setting generally have a time

[18] For more detail on the Bank of England's remit and practices, see Budd (1998) and Balls and O'Donnell (2002).

[19] Balls and O'Donnell (2002), Geraats (2002), and Goodfriend (2003).

horizon of perhaps 1–2 years, whereas expectations of carbon-tax levels influence investment in generating capacity that may last for several decades. A further caveat is that while Bank of England independence is widely seen as a success, some have argued that it has yet to be put fully to the test in very difficult economic or political circumstances. Nevertheless, the monetary policy analogy nicely highlights the options for enhancing carbon policy credibility.

4. An Energy Agency

How might such a combination of objectives, contracts, and delegation work in the carbon context? One proposal is to set up an energy agency analogous to the MPC of the Bank of England.[20] The government might commit to a CO_2 target—such as the 60 per cent target in the 2003 White Paper, discussed above. The energy agency could then be set a number of duties forming its 'contract' with government. The options are:

(i) a duty to meet the target by *any* means it deems suitable;

(ii) a duty to meet the target by setting a carbon-tax or emissions-trading limit; or

(iii) a duty to monitor the performance of the government in meeting the target, with published reports to the relevant secretaries of state indicating whether it is on target and with recommendations for appropriate action.

Clearly, (i) would be hard for any democratic government to concede. The nearest to the MPC version is (ii), but, given the reluctance of the Treasury to concede tax-setting powers, the most likely version of (ii) is delegation to a European body responsible for setting quantities for emissions trading, such that the price of permits (the analogy to the tax) is set by the less politically exposed process of the permits market. In the British context, (iii) is most plausible. It would increase transparency and hence credibility, but not be wholly convincing.

The opposition to the delegation of powers to an agency has a variety of forms, largely related to the political process. The creation of a new agency means a reduction in employment within existing government departments—in this case at the DTI and, to a lesser extent,

[20] This was first proposed in Helm (1992) and more fully articulated in Helm (2003*b*).

Defra. This is further complicated where it might involve the closure or slimming down of existing agencies or government offices outside the department, in this case Ofgem, the Energy Saving Trust (EST), and the Carbon Trust. On the reasonable assumption that the objectives of bureaucracy are to increase size and budget, there is an obvious conflict.

These instrumental and bureaucratic objections are compounded by the loss of control that delegation may entail. The time-inconsistency problem arises in part because governments have conflicting objectives, and electoral success depends upon the creation of coalitions of interest. It is often not an optimal *political* strategy to sharpen the trade-off and to expose the losers to a policy. A 60 per cent CO_2 reduction target for carbon will raise prices and reduce the competitiveness of the coal and large energy-intensive industries. Politically, it may be better to avoid the explicit recognition of these costs, and in consequence to pay the price of the lack of credibility. Unsurprisingly, then, the 2003 White Paper (DTI, 2003*a*) concludes that there is no need to change the machinery of government and then proceeds to make a series of changes *within* government, using the guidance to Ofgem (discussed above) as the mechanism to try to resolve the conflicts of objectives.

The institutional solution is complicated by considerations other than price and emissions specific to the energy sector—notably security of supply. Security of supply arises as a special problem in energy markets for several reasons. Electricity cannot be stored (except in limited forms, such as pump storage). Hence, there needs to be an instantaneous matching of supply and demand and, since demand is uncertain, a capacity margin is needed by way of insurance. But energy is also a complementary good—failure of supply has large-scale effects on the economy as a whole—as recently demonstrated by interruptions in supply in London, California, Tokyo, Norway, and Italy—and hence there is an additional reason for carrying excess capacity on the electricity system. [21]

Although it might be thought that these two energy-related problems could be addressed within separate agencies, there are good economic reasons for combining them. Given that the monitoring of CO_2 target performance and the setting of appropriate levels of carbon taxes or permits requires specialist knowledge of the energy sector, there are obvious institutional economies of scale in combining in one agency both the CO_2 and security-of-supply objectives. The conventional economic logic that there should be as many instruments as targets (see Tinbergen, 1952) does not carry over to institutions.

[21] There are parallel reasons why the government is unlikely credibly to commit to pay for sufficient excess capacity, to induce investors to build marginal plant (see Helm, 2003*b*).

Indeed, if economies of scale in expertise are sufficiently great, there is a case for one agency for each *sector*, and, indeed, the tendency towards sectoral agencies has been marked since the 1997 election, with the creation of the Strategic Rail Authority for railways and Ofcom for telecommunications and broadcasting. In addition, non-fossil-fuel technologies raise their own security-of-supply issues—notably the intermittency of wind power and the consequences of decentralization of plant within electricity networks.

The combination of security-of-supply and CO_2 objectives in one agency could, however, reduce the credibility of the CO_2 target, if there is a trade-off between these two objectives. But, even if there is a trade-off, it is relatively easily avoidable by using two instruments. Indeed, some argue that there is no trade-off and that the two are compatible, because energy efficiency and renewables *add* to security of supply, by increasing diversity (see EST, 2002; Hain, 2002). In the British case, there are likely to be conflicts, too: base-load coal-fired generation capacity is, in the short term, critical to supply continuity, but it is also the dirtiest form of generation.

The solution to this problem—of combining CO_2 and security-of-supply objectives—for the design of an energy agency is to have more than one instrument to address the two objectives: a carbon tax or permits scheme to deal with CO_2, and a capacity payment or similar mechanism to induce sufficient marginal investment. Thus, the energy agency could be designed with both objectives in mind at one of the following levels:

(i) a duty to meet both CO_2 and security-of-supply targets by any means it deems suitable;

(ii) a duty to set a carbon tax (or emissions trading limit) and a capacity payment (or similar mechanism) consistent with meeting both targets;

(iii) a duty to monitor the performance of the government in meeting both targets, with published reports to the DTI on security of supply, and to Defra on the CO_2 targets, together with recommendations for appropriate action.

Even if the agency has two instruments (a carbon tax/permits scheme and a capacity payment) with which to achieve two objectives, it might be argued that the political constraints on the delegation of the powers under (ii) and (iii) will result in reduced credibility. However, the costs of slightly reduced credibility are likely to be more than offset

by gains from the combined expertise, with the consequence that the two instruments are likely to be more accurately set.

5. Conclusion

Governments have been quick to sign up to targets for CO_2 reductions, especially where short-term costs are perceived to be small, and other changes in the economy—such as the contraction of the coal industry in Britain—mean that the targets will be met anyway. As the concern over climate change grows, and the easy early gains in emission reductions are exhausted, new tougher policies will be required. In Britain, the adoption of the 60 per cent target for 2050 provides a demanding policy objective. Its achievement depends upon the transition from a carbon-intensive to a low-carbon economy, with the associated consequences for investment in energy efficiency, renewables, and low-carbon technologies.

These investments are risky, not just in the normal commercial sense, but because their profitability at the margin is often largely or entirely dependent on government policy *over time*. The credibility of government CO_2 policy is therefore at a premium, and we have argued that there can be acute time-inconsistency problems in environmental policy. Governments have multiple objectives, limited instruments, and a history of non-credible policies. The 2003 White Paper provides several examples of non-credibility, notably the way in which the objective is supported by very weak empirical evidence and analysis, the aspirational nature of the 2020 targets for renewables and energy-efficiency measures, and the lack of coherence between the institutions responsible for delivering the policy objectives.

We have shown how the time-inconsistency problem arises formally, and set out a number of options to solve it. The most promising is the creation of an energy agency, and in practice it is likely that this will combine security-of-supply objectives with CO_2 ones. We have recognized the potential inconsistency faced by such an agency if it has both carbon and security-of-supply objectives, but fortunately there are two instruments available (a carbon tax/permits scheme and a capacity payment) and the gains from the combined expertise are likely to outweigh the weakening of credibility.

The idea that the solution to a credible carbon policy lies in institutional design is not one that appeals immediately to environmentalists, energy policy-makers, or, indeed, the DTI. We noted that, in the 2003 White Paper, institutional reform along the lines suggested here

was explicitly rejected. However, that rejection comes at a price: the consequence of the loss of credibility is that investment in energy efficiency and renewables will be lower than it might otherwise have been. The conclusion that the private sector may draw is that the government is not serious about its CO_2 targets and that investment in low-carbon technology is unlikely to be profitable. Political and bureaucratic objections to the transfer of functions from government departments will probably only be overcome when the costs of failure in CO_2 policy become so great, and so explicit, that the case for institutional change is overwhelming.