POLICY FRAMEWORKS FOR THE ANCILLARY BENEFITS OF CLIMATE CHANGE POLICIES

by David PEARCE

1. The issue

Most environmental policy is targeted at specific goals: a reduction in greenhouse gas emissions, achievement of some interim deposition or concentration level of air pollutants, improvements in water quality etc. These are *policy targets* or *policy levels*. Achieving given targets can involve different policy choices: standard setting, environmental taxes, public information campaigns, negotiated agreements etc. Many of these choices can be combined so that policy measures become *hybrids* or *policy mixes*. Any policy instrument or mix of instruments may have an impact on policy levels which are not the direct target of the policy in question. Thus, climate change policies which involve measures to reduce carbon dioxide emission levels may also have a number of other effects:

- reducing other pollutants that are jointly produced with carbon dioxide, e.g. nitrogen oxides, particulate matter and sulphur oxides;

- reducing other harmful impacts such as (traffic noise, road accidents, and community severance (e.g. loss of neighbourhood due to heavy traffic flows). A policy which seeks to reduce CO_2 emissions by controlling traffic might, for example, have the effect of reducing all these transport-related damages;

- possibly increasing employment levels relative to some baseline in which the climate policy is not adopted;

- possibly stimulating technological change.

Benefits which accrue as a side effect of targeted policies are known as *secondary benefits, policy spillover effects*, '*co-benefits*' or *ancillary benefits*. If it is legitimate to credit these benefits to the policy measures in question, then it is clear that their inclusion may change the way in which a policy is viewed. A policy that might not appear to be worthwhile in terms of the benefits and costs of achieving a given policy target, may become worthwhile if the ancillary benefits are credited to the policy. Similarly, some policies may involve the sacrifice of ancillary benefits, so that a secondary cost is involved, perhaps transforming a policy that was worthwhile into one that is not worthwhile. While the focus tends to be on ancillary benefits, the same logic entails that indirect negative consequences of a climate policy should also be accounted for, i.e. there may be *ancillary costs*[1].

Clearly, knowing the size of ancillary benefits has great potential significance for various aspects of policy and in particular: (a) whether or not *any* policy action is worthwhile, and (b) whether or not the total benefits of a policy can be increased by adjusting *policy design* (see Annex 1).

The issue is perhaps most important in the context of climate policy, but it is not confined to that concern. The reasons that ancillary benefits matter in climate policy are:

a) that there is some evidence to suggest they could be substantial, thus altering explicit or implicit benefit-cost ratios of emission control policies (Pearce *et al.*, 1996);

b) related to (a) above: that greenhouse gas control policies tend to have significant economic effects, reflecting the fact that carbon (in particular) is pervasive to the workings of most economies. This pervasiveness of policy effects has made some governments reluctant to embark on greenhouse gas emission reduction programmes for fear of widespread economic costs. The existence of ancillary benefits could make such programmes more attractive by effectively 'internalising' some of the costs of participating in an international agreement (Tol et al, 1995; OECD, 1999);

c) that policies of carbon trading under the Kyoto 'flexibility mechanisms' will tend to have *ancillary costs* to the investing (permit buying) country because of the reduction in domestic emission reduction action that occurs relative to the case where there are no carbon trades. This may affect the desirability of trading as a means of reducing compliance costs with the Kyoto Protocol (Lutter and Shogren, 1999). However, spillover effects from the investment in the permit-selling country could be positive, so that the *global net effect* could be positive or negative;

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1 Note that the 'with/without' principle in cost-benefit analysis automatically leads the analysts to account for all costs and benefits that occur because of the policy relative to the baseline of no policy. Nonetheless, ancillary benefits analyses have often adopted different scopes for what is and what is not included as cost and benefit.

d) that, whereas the *locational source* of greenhouse gas emissions does not matter if the focus is on greenhouse gas damage only[2], the location does matter if ancillary benefits are accounted for. Such considerations could, in principle, affect burden sharing rules for dealing with greenhouse gas emission reductions, i.e. the geographical distribution of emission reductions. Within the European Union, for example, there is a greenhouse gas emission reduction agreement which shares out the emission reductions required for the EU under the Kyoto Protocol. This burden sharing agreement appears not to have taken account of the associated effects of greenhouse gas reductions on the emissions of transboundary pollutants, despite the fact that there are several transboundary agreements on conventional air pollutants in the EU and in the wider Europe (Pearce, 1992; Heintz and Tol, 1996).

e) since different policies with equal greenhouse gas emission reduction effects can have widely varying ancillary impacts, policy design and selection becomes more complex.

The issues arising are therefore:

a) how can the significance of ancillary effects be demonstrated? This is the issue of methodology and demonstration;

b) once demonstrated, how can ancillary effects be integrated into decision-making? This is policy integration and overcoming barriers to implementation. Additionally, what methodologies are available for incorporating ancillary effects into policy design?

c) what are the implications of ancillary effects for choice of policy instrument – taxes, standard setting etc.? This is the issue of policy design.

The focus of this paper is on (b) and (c). The first issue is touched on only in so far as it is used to substantiate statements made in this paper.

2. Methodologies and demonstration

There are several reviews of the ancillary benefits literature (Ekins, 1996; Burtraw and Toman, 1997; Burtraw et al 1999; OECD, 1999). The literature tends to focus on *monetary estimates* of ancillary pollution damage from greenhouse gas emissions, the monetary value of reduced pollution damage from climate control, and employment impacts.

2.1 The methodologies used

Methodologies used in the literature for estimating ancillary effects vary.

2 This is because GHGs are *uniformly mixed pollutants*. Each tonne emitted does the same marginal warming damage regardless of its source of emission.

Some of the early literature (Pearce, 1992; Barker, 1993) take a ‘fixed coefficients’ procedure. Emissions of X tonnes of carbon are associated with Y tonnes of some other pollutant, so the value of ancillary damage is \$V.Y/X, where V is the marginal willingness to pay for the associated pollutant expressed per tonne of carbon. Such coefficients are essentially average and not marginal values, i.e. no account is taken of the future or ‘in the pipeline’ policy context. Marginal emissions could differ significantly from average coefficients and this could explain some of the relatively high values found in the European studies.

Estimates of the money value V in ancillary effect studies typically come from *benefits transfer* studies. Benefits transfer involves taking either a willingness to pay (WTP) value or willingness to pay function from a context where a study has been carried out (the ‘study site’) and applying it to another context (the ‘policy site’). Thus, a mean willingness to pay of \$A for avoiding the damage associated with one tonne of sulphur oxides emissions impact might be applied to the policy context in which Y tonnes of SOx are reduced as a result of a climate control policy. Alternatively, some WTP function, e.g. WTP = aI + bAGE + cEDUC, might be ‘borrowed’ from the study site and applied to the policy site. Here I = per capita income, AGE is average age of the affected population and EDUC = educational attainment of the affected population. The coefficients a,b,c are assumed to take the same value at the policy site, but the relevant values for I, AGE and EDUC are inserted in order to estimate a modified WTP. More detail on benefits transfer is given in Annex 2 which gives an overview of the general problems associated with methodologies using monetary values.

The policy approach simulates the effect of some policy, say a carbon tax, and estimates the reduction in associated pollutants, Y’ for a given policy that reduces carbon emissions by X’. Simulation involves a model of some kind, ranging from some environmentally modified input-output approach to full general equilibrium models. Again, the value of this reduction is then \$V.Y’/X’. In this case, however, Y’ need not be the same as Y since the reduction in Y is policy-dependent and, furthermore, Y’ may allow for general equilibrium effects whereas the simplistic approach using Y does not. Nonetheless, the ratio Y/X and Y’/X remain useful if inexact comparators (see Table 1 below).

Other approaches tend to focus on the physical effects without monetisation of those effects. The unit value V in the monetary approach, for example, should reflect the economic impacts of the associated pollutants on crops, ecosystems, human health and materials damage (and perhaps also visibility). Thus V subsumes a set of dose-response functions relating the pollutants to the various impacts. In non-monetary approaches, the physical effects are highlighted rather than having them valued in monetary terms. Thus, pollution reduction Y or Y’ is linked by dose-response functions to health effects H, say lives saved or life-years saved. An indicator of ancillary benefits is then H or H/X.

2.2 Monetary values

The monetary results are presented in different ways. Ancillary benefits are usually presented in absolute terms (e.g. $ per tC), as a multiple of 'primary' benefits (i.e. global warming damage avoided), or as a percentage of abatement costs. The focus on ancillary benefits as a multiplier of primary benefits tends to reflect a concern with benefit-cost. The focus on recovery of abatement costs tends to reflect a concern with no regrets policies, i.e. the larger the recovery fraction, the less 'regret' there is in climate change policy. OECD (1999) notes that the range of values, expressed per tC, is $3-88 for the studies with estimates for the USA (ignoring the early studies of Ayres and Walter, 1991) and $44-305 tC for the European studies[3].

The earliest references to the potential significance of ancillary benefits in GHG control appear to be Glomsrod (1990), restated in Alfsen *et al.* (1992), Ayres and Walter (1991) and Pearce (1992). Pearce's 1992 analysis suggested that ancillary benefits might be 8-21 times the 'primary' benefits (global warming avoided) in 2010 in the UK and 9-24 times in Norway for the same year, i.e. the UK and Norwegian estimates were similar. Barker (1993) confirmed that UK ancillary benefits were high, using Pearce's estimates, but building them into a full macroeconomic model.

These early studies formed the basis of IPCC's assessment of ancillary benefits (Pearce et al, 1996). IPCC was careful to point to the policy context involving ancillary benefits by saying that their existence did not *necessarily* amplify the justification for GHG abatement policy since policy that addressed the ancillary damages directly might still be preferred. It is possible that this view – that ancillary benefits are not relevant to climate policy because those benefits are more cost-effectively secured by policies directly aimed at the relevant pollutants - has inhibited the integration of ancillary benefits into climate change policy analysis, but it is difficult to find evidence that this is the case.

The IPCC study did not suggest any 'multiplier' for ancillary benefits, but did note that some studies suggested they could offset between 30% and 100% of abatement costs (Pearce *et al.*, 1996, p.218).

With the exception of Lutter and Shogren (1999), US studies have typically found multipliers of less than unity. A caveat to this conclusion is that it is difficult to secure a 'normalised' basis for the comparison, i.e. some studies look at the ancillary damage done from, say air pollutants, associated with the emission of one tonne of carbon. Others simulate the effects of carbon taxes. Studies also differ in scope, some focusing on the electricity sector alone and others estimating economy-wide impacts. The Burtraw *et al.* (1999) study finds ancillary benefits to be almost trivial relative to primary benefit estimates at $3 tC, but this is for a simulated $10 tC carbon tax. By contrast, the Lutter-Shogren study finds a value of around $300 tC.

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3 Ayres and Walter (1991) is one of the first studies to investigate primary and secondary benefits, but the study has been severely criticised for double-counting warming damages, and hence the benefits of control – see Fankhauser (1994).

It is worth noting that the Global Environment Facility (GEF) has routinely had to address the issue of ancillary benefits in its efforts to give substance and meaning to the notion of 'incremental cost'. GEF grants directed at global warming control have their main justification in the reductions in global GHG emissions. But ancillary benefits mean that recipients of grants may actually secure domestic benefits (e.g. technology transfer, local pollution control, employment) since they do not pay themselves for the GHG control measures. Clearly, a grant policy that ignored these domestic gains would have less effect on global warming control than one that required recipients to pay at least part of the cost of the GHG control policy. In the limit, recipients could pay up to the level of the domestic benefits received and still have an incentive to adopt the GHG control measure. This would free resources for new grants to other recipients, thus expanding the number of project that could be financed with a given budget. In practice, GEF tends to operate so that only some domestic ancillary benefits are deducted from the 'gross' incremental cost. Local environmental benefits may be computed but not deducted. Rosebrock (1994) suggests that such local environmental benefits may have money values of a size comparable to the GEF grant and to global benefits.

2.3 Overview of monetary estimates of emissions-related ancillary benefits

Table 1 lists estimates of ancillary benefits as a multiple of primary (marginal) benefits. It is important to understand what the computations show since, as noted earlier, the methodologies vary. To repeat the methodology - the ancillary benefits take the form of either emissions of air pollutants associated with the emission of one tonne of carbon, or the reduction in air pollutants associated with a particular policy that reduces carbon emissions by one tonne. The former approach is analogous to a 'fixed coefficients' procedure. Emissions of X tonnes of carbon are associated with Y tonnes of some other pollutant, so the value of ancillary damage is \$V.Y/X, where V is the marginal willingness to pay for the associated pollutant. The policy approach simulates the effect of some policy, say a carbon tax, and estimates the reduction in associated pollutants, Y' for a given policy that reduces carbon emissions by X'. Again, the value of this reduction is then \$V.Y'/X'. In this case, Y' need not be the same as Y since the reduction in Y is policy-dependent. Nonetheless, the ratio Y/X and Y'/X remain valid comparators. Table 1 shows these values in terms of \$V.Y/\$V.X and \$V.Y'/\$V.X. While the ratios cannot be strictly compared they give an approximate guide.

Table 1. **Ancillary (emission) benefits per tonne carbon as a multiple of primary benefits**

Study	**Country**	**Ancillary benefits in $tC**	**Ancillary benefits as a multiple of primary benefits (at $45 tC)[1]**	**Comment**
Ayres and Walter 1991	USA	165	3.67	
Barker, 1993	USA	251	5.58	VOCs
Boyd *et al.* 1995	USA	40	0.89	Criteria pollutants
Burtraw and Toman, 1998	USA	<10	<0.22	Judgmental assessment of prior studies
Burtraw *et al.*1999	USA	3[2]	0.07	SO_2, NO_x only
Dowlatabadi *et al.*1993	USA	3	0.07	SO_2, NO_x, PM
Goulder 1993; Scheraga and Leary 1993	USA	33	0.73	SO_2, NO_x, PM, Pb, CO, VOCs
Lutter and Shogren, 1999	USA	300	6.67	See text
Rowe *et al.* 1995	USA	24	0.53	SO_2, NO_x, PM
Viscusi *et al.* 1994	USA	88	1.95	Criteria pollutants
Barker 1993	UK	44-201	0.98-4.46	Relies on Pearce 1992
Pearce 1992	UK	195	4.33	SO_2, NO_x, PM
Ayres and Walter	Germany	312	6.93	
Alfsen 1992	Norway	102-146	2.27-3.24	
RIVM et al 2000	European Union	53- 79	1.17-1.75	General equilibrium model

Sources: OECD (1999); Lutter and Shogren (1999); RIVM et al (2000). The primary benefit figure for warming damage avoided is from Eyre *et al.* (1997) – see Annex 2.

Notes:

1. The $45 damage figure is an estimate of marginal warming damage from the release of one more tonne of carbon now. The damage figure rises over time in some models but only at a modest rate(Pearce et al, 1996).
2. This figure would be approximately doubled if savings on SO_2 control costs are included.

Table 1 reveals a very wide range of estimates. Differences would appear to be due to a number of factors. First, methodologies differ. Some of the estimates are simplistic in that they come from correlations between emissions of CO_2 and the conventional pollutants. These cross coefficients are averages in some cases (e.g. the early UK work) and marginal figures in other cases. Either way they take no account of 'policy in the pipeline'. The fairly stringent controls on SO_x and NO_x, say, would have the effect of lowering the amount of these pollutants emitted, so the cross coefficient will fall over time. Hence these early estimates are almost certainly exaggerations. Other estimates come from the running of various models of different degrees of sophistication. These are more reliable. Second, the estimates derive in some cases from simulations of carbon taxes and the tax rates used vary from a few dollars per tC to very high rates. Since the results in Table 1 are shown in the form of emissions per tonne of carbon, this normalisation procedure should remove most of the variability due to different carbon tax rates, but if higher tax rates have a bigger proportional effect on carbon emissions, then the results will vary.

Nonetheless, even accounting for these differences, the impression remains that ancillary benefits *could* be comparable in size to the 'primary' (global warming) benefits. Just as significantly, ancillary benefits offer significant potential for no regrets policies, i.e. significant fractions of abatement costs are recovered, at least for early measures.

2.4 Overview of non-monetary ancillary benefits

2.4.1 Emissions

As an example of ancillary emissions reductions that are not monetised, Bernow and Duckworth (1998) estimate that a policy package in the USA which reduces CO_2 emissions by 10% by 2010 (relative to 1990) would have the following effects: a reduction in SO_2 emissions by 5.5 mt SO_2 over and above Clean Air Act achievements compared to the 2010 base case; 4 mt NO_x; c8 mtCO; 300,000 tPM, and 750,000 tVOCs[4].

An OECD wide perspective is provided by Complainville and Martins (1994) Using the OECD 'GREEN' model they simulate an escalating carbon tax and estimate the effect on CO_2, SO_x and NO_x emissions. Some of the results are shown below.

Table 2. **Effects of a carbon tax on NO_x and SO_x emissions: OECD 'GREEN' model**

[Tax of $22 tC in 200, rising to $156tC in 2050. Impact shown as % deviation from baseline emissions]

	2000			2050		
	CO_2	NO_x	SO_x	CO_2	NO_x	SO_x
USA	-8	-8	-13	-55	-45	-64
Japan	-4	-3	-4	-48	-35	-41
EU	-5	-4	-7	-45	-34	-48

Source: Complainville and Martins (1994).

[4] The implied cross-coefficients are not very different to those derived by Pearce (1992) for the UK, i.e. tonnes SOx etc. per tC reduced.

The most notable observation is that, in terms of percentage deviations, the effects on NO_x and SO_x are as pronounced as they are for carbon dioxide.

2.4.2 *Health benefits*

An example of ancillary benefits expressed as 'lives saved' is given by The (international) Working Group on Public Health and Fossil Fuel Combustion (1997). They estimated that a climate policy that reduced developed country CO_2 emissions 15% below their 1990 level would save a cumulative total of some 8 million lives from 2000 to 2020 due to ancillary reductions in particulate matter. Some 6.3 million of the total would be in developing countries and 1.7 million in developed countries.

2.4.3 *Employment*

Employment effects tend to be estimated in studies that adopt macroeconomic or general equilibrium modelling of climate improvement policies. Most studies find that climate control policies have a net cost in terms of GNP and hence, most likely, a net cost in terms of employment (Hourcade, 1996). A few studies, notably for the UK, suggest employment gains from GHG control. The former might suggest ancillary costs, the latter ancillary benefits.

There are a number of problems associated with including employment as an ancillary effect.

First, in a fully fledged cost-benefit study the net effects of any measure will be measured in terms of changes in human wellbeing. If wellbeing is measured in terms of changes to GNP, then adding in employment gains as well as the GNP gains would be double counting. Properly conducted, CBA would identify wellbeing changes that subsume the GNP gains, so that employment would properly be excluded from any benefits assessment. As we note later, however, ancillary effects analysis may well not take the form of a cost-benefit study. If so, and provided care is taken to ensure that double counting is not present, gains (or losses) in employment could be included.

Second, the extent to which employment changes as a result of GHG policy is sensitive to the form that the policy takes. Most notable is the sensitivity to revenue-recycling, i.e. to the use made of any revenues from carbon taxes and (less likely) auctioned tradable permits. As a general rule, if revenues are recycled, employment gains will be higher. However, there is a substantial debate on which form of recycling matters most – notably reductions in labour taxes, reductions in personal income taxes, reductions in corporate income tax or increases in investment allowances (Shackleton et al, 1992). Some experts cast doubt on whether any of these apparent benefits should be regarded as a credit to GHG control, policies. The reason for this is that the size of the employment/GNP gain is determined by the scale of the economic distortion already embodied in the tax that is reduced with the recycled carbon tax revenues. But if the outcome occurs because the taxes that are reduced are already distortionary, those taxes should be reduced anyway. It therefore amounts to 'claiming too much' for climate change policies that they have these employment effects. Against this, one has to ask whether such anti-distortionary policies would have been taken in the absence of GHG control measures. GHG controls will impose some costs on emitters and it could be argued that revenue recycling is away of 'buying' the co-operation of emitters. Put another way, the issue is one of what constitutes the 'political baseline': a set of distortionary taxes that should have been eliminated (or reduced) anyway, or a set of distortionary taxes that are not likely to be reduced in the absence of climate change policy.

Overall, if the ancillary benefits issue is regarded in purely analytical terms, employment gains – if they occur – would not seem relevant. Either they reflect gains in wellbeing that are already accounted for in, say, a cost-benefit analysis, or their occurrence reflects distortions in the economy rather than the beneficial effects of climate policy. There is, in effect. No 'double dividend'. A more down-to-earth view would add in employment gains if the decision-guidance is not presented as a cost-benefit analysis, though care has to be taken not to double count. Similarly, the double dividend argument appears more sound if the climate change policy really can be seen as the route for reducing distortions that would not otherwise be reduced

2.4.4 Technology-forcing

Arguably, a GHG control policy will stimulate technological change in the abatement sector. However, the extent to which such technological developments should be regarded as an ancillary benefit is debatable. If the benefits of the improved technologies 'spill over' to other sectors –e.g. to the control of other pollutants – then it would seem correct to count any likely cost savings as a benefit to climate control measures. If the cost reductions are confined entirely to the GHG control sector then it is less clear that the future cost reductions should be credited to the policy since those cost reductions should be built into the GHG abatement cost estimates. There appears to be very little evidence about the effects of policy measures on technology spillovers, although there are some studies that try to estimate the technology forcing impacts of policy *in general*. Thus, Kemp (1997) finds that impacts on technical change are dependent on the form that policy takes. In contrast to many of the theoretical expectations, he argues that tradable permit systems are the most technology-forcing and environmental taxes the least forcing, with traditional command and control measures in between. The comparatively poor performance of taxes reflects the fact that they tend to be introduced at too low a level for fear of industrial lobbies against them and perceived impacts on competitiveness. Thus it is important to distinguish the likely effects of 'properly' designed taxes from the taxes that are likely to be introduced in practice.

Kemp (1997) does consider the more relevant issue (for the current topic) of how far any new technology is *diffused*. GHG control technology will, for example, largely focus on energy saving and energy saving is just as relevant to conventional pollution control. The results of Kemp's analysis of various case studies in the Netherlands are not clear-cut. Diffusion of conservation technologies is not readily explained by cost advantages. Even the availability of subsidies to energy conservation could not explain take-up. Institutional factors mattered, e.g. the take up of energy conservation in rented homes was as large as in owner-occupied homes, a result mainly due to the environmental consciousness of the non-profit housing councils that own most rented accommodation. But the potential for diffusing technology across different sectors is high because technological solutions often exist outside of the sector being targeted.

Overall, there is some evidence that 'technology forcing' is an outcome of the kinds of policies that would be relevant to GHG control. However, the extent to which this forcing effect can be regarded as an extra, ancillary, benefit of GHG control seems best supported if the effects are diffused outside of the sectors targeted for GHG control. This ''partial diffusion'' of benefits is difficult to identify but appears to exist. Its size is probably not something that can be demonstrated in quantified terms.

2.5 Should ancillary benefits be counted at all?

Some economists doubt if ancillary benefits should be included at all in an analysis of the benefits and costs of climate change policy. Shogren (1999) warns against the possibility of double counting since existing policies targeted at the ancillary concerns (e.g. acid rain) may well account for future reductions in ancillary pollution. Counting them in again would be to exaggerate the benefits of climate control policies. This risk can be overcome by ensuring that any ancillary emission reductions are truly incremental to ancillary policies. Shogren notes that if ancillary emission policies are effective they will capture the net benefits of controlling ancillary emissions. This is true but it presupposes that ancillary emission policy is itself optimal. Cost-benefit studies of acidification control, at least in Europe, suggest that there are still major net benefits to be captured.

3. Policy integration and overcoming barriers to implementation

3.1 Decision-criteria and ancillary benefits: no regrets policies

Faced with a trade-off context, any policy maker will first try to secure a no-regrets policy stance. There are various meanings to 'no-regrets'. We can distinguish three for purposes of analysis.

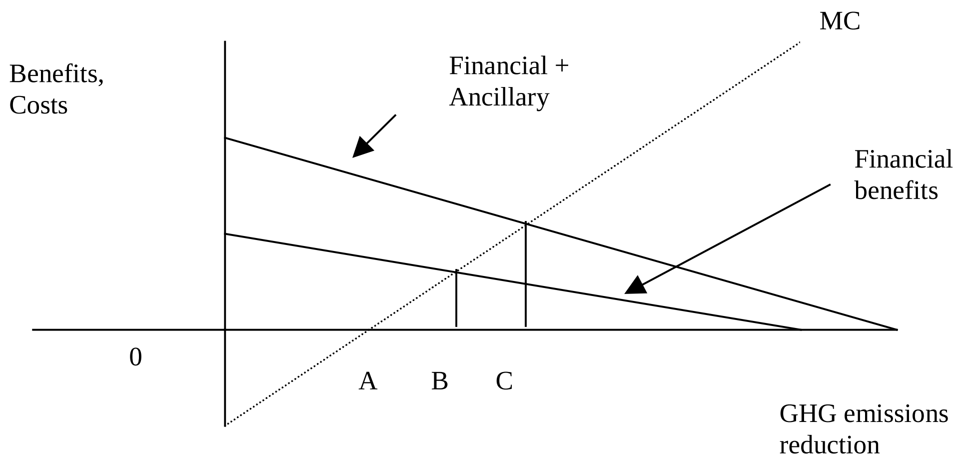
First, no regrets may be defined in such a way that all measures having negative or zero costs are implemented. Since the benefits are assumed to be greater than zero, there is no need to quantify benefits. All measures can be ranked according to the size of negative costs. Strictly, the measures need to be normalised in terms of the tonnes of GHGs reduced, i.e. the appropriate indicator becomes (negative) cost per tonne of Cequ reduced.

Second, no regrets could be defined as a context in which *financial* gains exceed any (positive) financial costs of the policy. One example would be the financial savings from an energy conservation programme which could outweigh the financial costs of the policy. A more subtle example might be that climate policy reduces local pollutants which in turn reduces morbidity and premature mortality. In turn, these benefits are associated with some financial returns, such as reduced health care expenditures. Overall willingness to pay to reduce the health effects would, not, however, be part of the cost-benefit equation since this does not have a direct financial flow associated with it.

Third, no regrets could be defined as a context in which the costs are covered by the financial benefits and monetised estimates of ancillary benefits. Dessus and O'Connor (1999), for example, find that, even with conservative assumptions about willingness to pay for health benefits, Chile could reduce CO_2 emissions by 10% from a 2010 baseline level without any losses to national wellbeing, all costs being offset by ancillary benefits.

Figure 1 illustrates these three different concepts. Benefits and costs in money terms are measured on the vertical axis, and GHG reduction levels on the horizontal axis. MC is the marginal cost of emissions reduction. The line marked 'financial benefits' refers to marginal financial gains. The line marked 'financial and ancillary' refers to marginal aggregate financial and non-financial gains. Note that the global benefits of reduced warming are not included in this analysis. The very narrow definition of no-regrets is illustrated by all actions up to point A. The definition involving financial benefits covering costs is shown by level B, and the definition involving ancillary benefits is shown by level C. As can be seen, assuming there are no ancillary costs, the effect is to increase the warranted level of GHG reduction as the definition is relaxed.

Figure 1. **No regrets measures**



Some of the climate control literature lends support to the narrow definitions of no-regrets being the case, at least for the early actions on climate change control. This is because mainly ‘bottom up’ cost studies have argued for significant actions that have negative financial costs, especially in the area of energy conservation. If this were true then finding any positive ancillary benefits would be ‘icing on the cake’ – climate policies essentially pay for themselves and the reduced local pollution and other benefits are an incidental gain. The problem is that there are extensive doubts surrounding the view that control costs can be negative since the question is why such investments are not undertaken automatically. Others note that the almost exclusive preoccupation of the business and economics literature is with the *management* of corporations, which suggests that there are issues that need to be managed. What is privately profitable simply does not happen automatically. Hence negative costs may exist but may not translate into automatic action by corporations. There may be many informational, principal-agent and institutional obstacles to implementing good policy[5]. If so, a climate control policy might be as good as instrument as any to draw attention to those negative costs and to initiate managerial policies to exploit them. Indeed, this has been the thrust of many environmental audit and reporting schemes.

On this narrow definition of no-regrets the role played by ancillary benefits is essentially a supportive one, i.e. policy should be self-financing without consideration of ancillary benefits.

[5] This literature is reasonably large. See, for example, de Canio (1995).

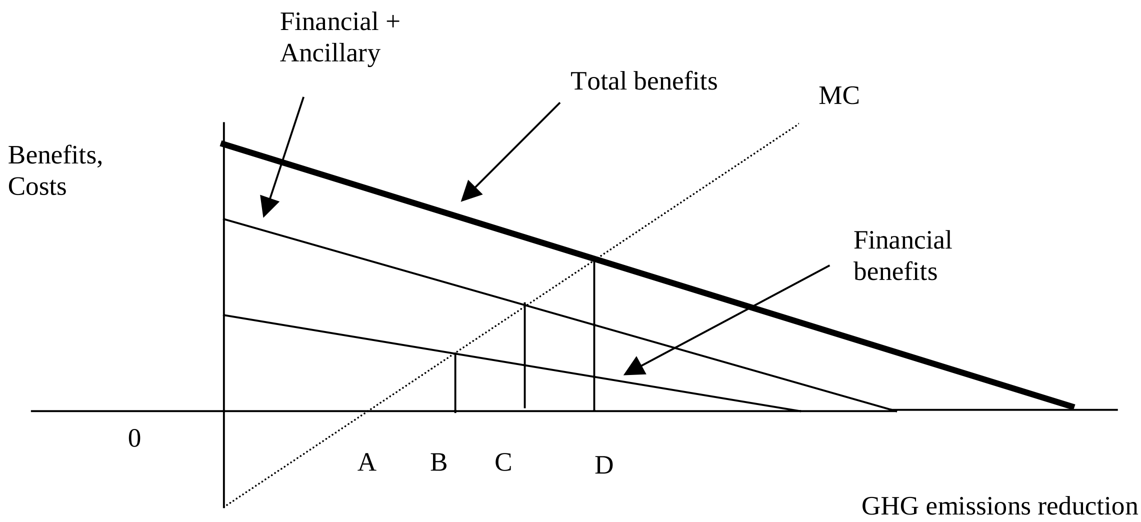
The broader definition of no regrets (option C in Figure 1) suggests that climate control measures may not be financially beneficial in terms of private costs, but are beneficial to the nation implementing controls when ancillary benefits are added. The policy difference is considerable. Self-financing measures centre round information, auditing, exhortation and 'public reward' (e.g. prizes). Measures that require their justification in terms of ancillary benefits are far more likely to need financial incentives such as taxes and subsidies. Politically they are obviously far more difficult to secure since there will always be losers. Just as we identify a 'loss aversion' culture among political decision-makers (see below), so there is a 'loser syndrome' in policy making in general. As long as there are losers who are not clearly compensated for their losses, they have a strong incentive to lobby against the measures in question. Hence, getting ancillary benefits 'on to the agenda' is far more difficult than managing the narrow concept of no regrets: for now there are losers and there is no obvious way in which the gainers (from reduced pollution, say) can compensate the losers (the firms bearing the costs).

3.2 Decision-criteria and ancillary benefits: cost benefit analysis

If cost-benefit analysis (CBA) was the sole procedure whereby decisions about environmental policy were made, then, apart from the issue of reliability of estimates, the ancillary benefits issue would not be so controversial. The reason for this is simple: CBA requires that all costs and benefits be accounted for when computing a cost-benefit ratio or present value total. That accounting procedure operates on the 'with/without' principle, i.e. costs with the policy are defined relative to the baseline of 'no action'. Similarly with benefits. Hence, in a 'cost-benefit world', the issue of how to get ancillary benefits into practical decision making would be redundant. It would tend to happen automatically. One technical qualification to this view is that benefits that take the form of stimulated technical change or employment might not easily be 'monetised'. Hence one could have a situation in which monetary benefits are less than monetary costs but employment and technical change benefits are positive.

The cost-benefit paradigm is illustrated in Figure 2 which repeats Figure 1 but now with the global benefits added. The global benefits take the form of reduced global warming damage. Chapter 2 suggested that 'benchmark' figures for (marginal) damage might be around $45 tC. Note that the cost-benefit approach is here interpreted to be inclusive of global and domestic benefits, even though the benefits of action do not accrue to the emissions-reducing nation. The rationale here, of course, is that the very purpose of emissions reduction is to secure global benefits so that it is legitimate to account for the benefits of reduced warming, regardless of to whom they accrue. Note that the 'optimal' level of emissions reduction is now at D.

Figure 2. **Cost-benefit approach**



While cost-benefit analysis is widely used in OECD countries it is not used consistently nor, when it is used, is it necessarily carried out with strict adherence to the 'with/without' principle. More relevant is its limited use in the context of climate change policy.

Since all countries with agreed targets under the Kyoto Protocol negotiated those targets at Kyoto there is no suggestion that formal CBA determined the burden-sharing targets, but the question can be asked as to whether existing CBA studies influenced the negotiating stance of the countries in question. It seems likely that various cost-benefit studies had some influence. Studies such as Nordhaus (1991, 1994) and Manne and Richels (1992) had suggested either that the 'optimal' trajectory of carbon emissions differed very little from 'business as usual' trajectories, or that significant control was far better undertaken well into the future rather than currently. Nordhaus's 1994 study suggested that even the voluntary emissions 'freeze' agreed at Rio in 1992 had negative net benefits[6]. There is little or no evidence to suggest that these studies were very influential, however. As many commentators have noted, policy-makers have been far more concerned with the short-term costs of mitigation than with longer-term balances of benefits and costs. The IPCC review of abatement costs found substantial disparities between 'bottom up' studies – suggesting negligible or small unit control costs – and 'top down' studies which suggested annual costs equivalent to 1-2% of GNP (Hourcade et al, 1996). From a policy-maker's standpoint, such ranges are not treated as if they have a simple expected (mean) value because there is substantial 'loss aversion' in decision-making.

[6] These studies appear to have had more infuence than those claiming high benefit-cost ratios – e.g. Cline (1992) – perhaps because the more action-oriented studies still suggested costs in excess of benefits for the first one hundred years. See for example, the graph in Cline (1992, p280).

Far more weight will be attached to the adverse estimates (i.e. the high abatement costs) than to the estimates suggesting only a small cost sacrifice. Loss aversion is easily explained. The perception is that the gains from climate change control will be long-term, whereas the costs of control will be immediate. This perception is correct even allowing for the strong possibility that climate impacts from global warming are already being felt. Even if strong action was taken today, there would be no discernible effect on rates of warming for considerable periods of time due to thermal lag effects. Hence anyone advising that strong action needs to be taken now would in effect be arguing for potentially significant costs to be incurred now for no identifiable benefit over fairly long periods. The role that ancillary benefits could play here is noteworthy since the policy lag effects for other pollutants are substantially less. Thus, while global warming benefits are long term, ancillary benefits could be fairly short-term.

In so far as ancillary benefits are presented in monetised form, it seems fair to say that their integration into climate policy decisions is problematic for precisely the same reason that cost-benefit is problematic. While it is far from clear that any other form of decision-guidance performs better, it remains the case that cost-benefit is controversial.

Widely used for regulatory impact appraisal in the USA, the impact of cost-benefit analysis elsewhere has been limited. The European Commission now regularly subjects planned Directives to cost-benefit appraisals, and there is strong support for cost-benefit in the UK and Scandinavia. Other countries are known to experiment with cost-benefit analysis, but most decision-making is only partially informed by quantitative techniques generally, whether cost-benefit or some other technique. On the various country experiences, see Department of the Environment (1997), Pearce (1998a) and EFTEC (1998) for the UK; Navrud and Pruckner (1997) and Pearce (1998b) for the European Union; Hahn (1996), Morgenstern (1997) and Farrow and Toman (1999) for the USA; and Nyborg (1996) for Norway.

The variable use of cost-benefit analysis can be explained by a number of factors, some of which, it is important to note apply to any quantitative procedure.

First, in so far as the techniques are on the political agenda, the controversies listed in Annex 2 have served to limit its credibility. Some issues, such as the appropriate value for a 'statistical life', are the subject of continuing debate among academics. The sensitivity of so many cost-benefit studies to this value suggests that it is an issue in need of urgent resolution before cost-benefit is likely to secure a stronger foothold in the decision-making practices of many countries (Pearce, 1998a, 1998b). Similarly, ancillary effects appraisal to date has been exclusively dependent on 'benefits transfer' estimates. Yet it is only recently that any significant effort has been made to test the validity of benefits transfer. While some exercises, whereby transferred values are compared to values derive from original valuation studies at the same site, find 'acceptable' errors in the transfer process (Ready et al, 2000), others suggest that transferred values are nowhere near to the values derived from original studies (Barton, 2000).

Second, the institutional structure of the decision-making units within government militates against fully integrated policy making (this holds whether the benefits are monetised or not). Thus the divisions of government making decisions about policy stances on climate change may be divorced from those making decisions about local or regional air quality. Repeated efforts to 'join up' government departments have not been very successful in many countries, so that policy thinking tends to be dictated by single rather than multiple goals. Perhaps just as seriously, climate decisions may not be informed by economic thinking over and above the costs of abatement since climate is regarded as an issue of 'science' first and the politics of international negotiation second. The cost-benefit paradigm may have little relevance to this institutional structure.

Third, whilst thinking about ancillary benefits does not have to involve cost-benefit analysis, there is evidence to suggest that almost any formal guidance procedure that is quantitative in nature is resisted by politicians. Nyborg (1996) interviewed Norwegian politicians to test their reactions to CBA and found that, at best, benefit-cost ratio s were used to 'screen' options, whereas the real process of ranking options was regarded as a 'political' process which was sensitive to whatever local conflicts there were. EFTEC (1998) interviewed UK civil servants and found a number regarded techniques such as CBA as inhibiting of the flexibility that politicians preferred to maintain. That is, CBA tended to remove the element of choice that politicians wished to have. Note that this objection may not hold so strongly with other techniques such as multi-criteria analysis where there is more scope for the decision-makers themselves to adopt the relevant scores and weights. In CBA there is no independent scoring of impacts, and weights are set by estimates of WTP. Navrud and Prucker (1997) found that European decision-making 'culture' was not so oriented towards economic efficiency as in the USA. Hence techniques such as CBA are downplayed. Pearce (1998a) found that CBA was more widely used in the European Commission because of revisions to the Treaty of Rome requiring that some form of cost-benefit balance be applied. It was not obvious, however, that the studies had been influential in modifying Directives.

Fourth, like any quantitative technique, CBA requires some degree of technical understanding. Its influence is therefore limited to those with an economics training or those able to apply themselves to acquiring the essentials of the subject. Since it is not a static procedure – techniques change fairly rapidly – there are serious learning costs involved. This may inhibit the use of the techniques.

How far, then, would these obstacles to implementing ancillary benefits analysis be overcome of non-monetised impacts were measured instead? Certainly, issues of technical understanding and decision-maker flexibility would be overcome to a considerable extent. It is also possible that the scientifically trained would be more 'at home' with non-monetised approaches. But such approaches would do nothing to avoid the institutional separation of climate change policy from policy concerned with more localised or national benefits. Nor would some of the technical controversies in CBA be avoided – e.g. the level of population over which to aggregate the non-monetary benefits. Finally, while it is often suggested that monetised costs and benefits add to uncertainty in decision-making, the uncertainty associated with the alternative is often overlooked. It is not clear, for example, that the uncertainty of decision-making associated with monetised estimates is any less than the uncertainty associated with not having any monetised estimates at all.

All this suggests that the search for a refined methodology of ancillary benefits analysis can contribute something to raising the profile of ancillary benefits in policy making, but that some of the obstacles are more deeply seated in institutions, administrative culture and technical capability.

A major emerging area where benefit-cost considerations are relevant, however, is in the determination of the stance that individual countries are taking with respect to carbon trading under the various Kyoto flexibility mechanisms. The essence of the situation is that trading shifts the control effort ‘offshore’ to EITs (in the case of joint implementation) and developing countries (in the case of the Clean Development Mechanism). But if carbon is reduced offshore none of the joint benefits of reducing carbon ‘onshore’ is realised. There is little evidence that this domestic cost of trading affected national attitudes at Kyoto, and the issue was not really relevant prior to Kyoto since, although there have been hundreds of actual or simulated trade, their focus has been on learning to execute, monitor and verify such trades, rather than on their costs and benefits. It thus appears to be very much a post-Kyoto concern. Attitudes in the European Union have also only recently begun to take account of the loss of ancillary benefits (it is – January 2000 – an active issue under consideration). Most considerations of trading have centred on the essentially moral-cum-political issue of whether trading reduces developed countries’ ‘responsibility’ for GHG emissions[7]. Recent studies, however, have raised the profile of trading by noting (a) the substantial reductions in costs achievable through trading, and (b) the loss of significant ancillary benefits if trading takes place (e.g. RIVM *et al.*, 2000). Since the physical ‘metric’ consists of tonnes of different gases (CO_2, NO_x etc) the trade-off between cost reductions and loss of ancillary benefits can only be expressed in monetary terms. Hence the new interest in the money value of ancillary benefits.

Overall, then, monetised ancillary benefits have, until very recently, played virtually no role in determining decision-maker attitudes to the policy mix of control measures. There is now evidence to suggest that such estimates are regarded as being relevant to one significant part of GHG policy, namely the extent to which carbon trading should be ‘allowed’ and encouraged.

3.3 Decision-criteria and ancillary benefits: risk assessment

The term ‘risk assessment’ (RA) is used in different ways within the OECD countries. The main differences are:

1. looking at the risks (probabilities and size of hazard) without monetising the risks and without considering the costs of reducing risks;

2. looking at the non-monetised risks and comparing them to the costs of control (cost-effectiveness);

3. looking at monetised risks and the costs of control (cost-benefit analysis).

Other variants exist (see EFTEC, 1999) but these are the main ones of concern. Since cost-benefit analysis has been discussed, only a) and b) are relevant to this section.

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7 There is an additional concern. The less abatement that occurs ‘at home’ the lower might the stimulus be to technological change which lowers future abatement costs for greenhouse gas emissions. Thus more trading could effectively keep abatement costs higher than they otherwise would be. I am grateful to Gene McGlynn for drawing this to my attention.

Ancillary benefits analysis fits neatly into the framework of risk assessment. As with CBA, the aim would be to identify the benefits of any global warming strategy, where the benefits will be GHG emission reductions, ancillary pollutant emission changes, and perhaps any technology-forcing effects and employment effects. Risk assessment that ignores costs altogether is not economically rational (although it does describe how some chemical RAs are carried out). Hence, focusing on cost-effectiveness, the obvious issue is how to deal with multiple benefits and a single cost figure. So long as there is 'vector inequality' between different policy options, the problem of multiple effects does not matter[8]. But once benefits and costs vary between policy options, some form of weighting is required. CBA presents one form of weighting using (marginal) willingness to pay as the weights. Multicriteria analysis is another option. In both cases there are serious problems of comparability. Long term effects (such as warming reduction) and being traded off against short-term effects (such as reduced traffic congestion etc). Some people adopt a standpoint that such trade-offs are not ethically acceptable since the current generation will automatically 'vote' to reduce short-term impacts at the expense of long term impacts they are unlikely to bear. This issue defines an on-going debate in the global warming literature, with some commentators taking the view that it is just as indefensible to allocate resources now for long-term gains to generations who are likely to be better off anyway, at the expense of the underprivileged now (Schelling, 1992, 1999).

The central point is that ancillary benefits can be integrated into 'standard' decision-making methodologies, but that in moving away from 'single target' policies aimed at reducing global warming there is inevitably a trade-off between some effects and climate effects. Put another way, the chances that climate policy is a 'win win' positive sum game are not high. This contrasts with some of the more radical claims made in the climate policy literature.

3.4 Decision-criteria and ancillary benefits: rapid appraisal

While in principle ancillary effects analysis can be accommodated fairly straightforwardly into no regrets, CBA and risk analysis, there is a demand among decision-makers for less sophisticated but more rapid assessment procedures. Some of this demand reflects limited time and resources for fuller-scale study, but some of it also reflects the current need simply to demonstrate the relevance of the ancillary benefits argument. This process of demonstration is not dependent on numbers being very precise.

The most basic rapid appraisal technique is the *checklist*, whereby when looking at different GHG policies, decision-makers are automatically reminded of the need to consider the ancillary costs and benefits of any chosen action. At the minimum, the checklist simply lists the like 'cross effects'. Thus a transport-targeted policy would list potential effects on noise nuisance, vehicle pollutants, congestion etc. An electricity-targeted policy would list impacts from other pollutants etc. It is not enough to list the associated emissions, since decision-makers need reminding of the impacts of those emissions. While simple checklists of this kind may seem redundant in a world where there are sophisticated decision guiding procedures available, interviews with numerous decision-makers across a number of countries suggests that their provision is essential.

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8 Let the benefits of a policy be B1,B2,B3 and B4 where the benefits are in non-monetary units. Let the cost be C. Vector inequality exists when B1/C, B2/C, B3/C, B4/C is greater than the corresponding ratio of benefits to costs for an alternative policy.

After this simple provision, checklists can be expanded to various levels of sophistication. Thus, 'cross coefficients' indicating the likely tonnage of pollutant reduction per tonne of GHG reduction could be provided, sector by sector, policy by policy. Some indication of the importance of impacts could be provided, e.g. by noting that, say, reduction in particulate matter is thought to be the most important with respect to human health effects.

Several problems emerge with rapid appraisal approaches. In principle, these are issues that can be accommodated within the cost-benefit and risk appraisal paradigms. In practice, it is likely that the issues will present problems even for these approaches.

The first issue concerns the timing of the benefits and costs. For climate change the perception is that the costs have to be borne now and the benefits are very long term. For the ancillary effects benefits are shorter term and costs are also borne now[9]. Traditionally, decision-makers have difficulty when dealing with long time horizons and this helps to explain some of the reticence to enter into radical agreements on climate change control. Attempting to integrate concerns with such different time horizons is problematic. The cost-benefit approach 'solves' the problem through the practice of discounting, but discounting long term effects tends to conflict with concerns about intergenerational equity, as is well known.

The second issue concerns the scientific certainty about effects. Climate change impacts remain uncertain. The environmental impacts from conventional pollutants are far better known, although considerable uncertainty surrounds some of the effects, e.g. the links between acidic pollutants and forest damage for example. Effectively, then, the decision-maker is being invited to 'mix' issues with very different ranges of confidence attached to them. Again, the cost-benefit approach would handle this with various approaches to uncertainty: sensitivity analysis, expected values, expected utility approaches, decision-criteria. While this may still leave the decision-maker with concerns over the validity of integrating ancillary benefits into climate policy, uncertainty is perhaps not as major a challenge as the time dimension issue.

The third issue concerns the availability of technical solutions, many of which, but not all, will be 'end-of-pipe' technologies. Conventional pollution tends to be tackled with technology requirements (see Section 4.1.1). While end-of-pipe solutions exist for greenhouse gas emissions they are currently not widely regarded as part of near-term climate change policy packages, mainly due to the need to demonstrate such technologies and their cost. Climate change can therefore only be tackled in the near-future through behavioural change, including fuel switching, energy conservation, and renewable energy. As noted above, that change has to be widespread simply because carbon is pervasive to the modern economy. Again, it may therefore appear to a decision-maker that the two sets of impacts need separate rather than integrated treatment.

9 This contrast should not be exaggerated. Ecosystem impacts from acid rain tend to be long term, as is ecosystem recovery when pollution is reduced.

3.5 Conclusion on barriers to integrating ancillary effects into policy analysis

This chapter has surveyed some of the salient barriers to integrating ancillary effects into policy analysis. Section 3.1 suggested that the presence of ancillary effects could greatly enhance the potential for 'no regrets' approaches to climate change policy. In turn, this should increase the political acceptability of climate policies. If there are financial no-regrets, i.e. there are real cash flows accruing back to those who bear the cost of the policy, then corporate opposition to climate policies may be reduced. Where the no regrets extend to non-monetary gains, then governments should, in principle, anyway, also be induced to adopt more rather than less climate control. But non-monetary gains will not necessarily accrue to those bearing the cost of climate policy so that there may still be 'losers' in an apparently no-regrets policy. What is no regrets at the social level need not be no regrets at the individual firm or industry level.

Section 3.2 looked at the cost-benefit paradigm and noted that, if properly executed, cost-benefit analysis automatically accounts for ancillary benefits and costs. Moreover, given that governments have positive discount rates, the fact that ancillary benefits occur in the near term (as well as the long term) whereas primary benefits from climate change occur only in the long term means that ancillary effects may further induce governments to adopt climate change policies. The drawback is the uncertainty surrounding monetised estimates of climate change damage. It is far from clear that uncertainty is reduced by omitting monetised damage estimates - a different form of uncertainty is introduced, namely any idea of whether gains exceed costs – but there is a political perception that monetised estimates have low credibility, especially where they include global estimates of non-market effects such as changes in disease vectors, ecosystem change and so on. Section 3.2 also raised an institutional question. Despite the claims of some governments concerning the integration of environmental issues into all government policy, much policy continues to be 'compartmentalised' within different agencies and ministries. This inhibits those charged with the responsibility of effecting climate change policies from taking account of ancillary effects since the two policies are unlikely to be integrated within one institution. Perhaps this observation explains why, despite the natural potential of cost-benefit analysis to handle the ancillary effects issue, the cost-benefit approach still seems under utilised.

Section 3.3. argued that ancillary effects are similarly fairly easy to incorporate into risk assessment procedures. The qualification is that one more impact is added to other impacts which are not in monetised form, thus requiring the use of some form of multi-criteria analysis.

If formal appraisal procedures are not widely used, how can ancillary effects analysis be integrated into the less formal 'rapid appraisal' approaches to policy? Section 3.4 suggests that, in principle there is no difficulty in adding the ancillary effects into checklists and approaches using 'scores' and 'weights'. In practice the absence of formal rules for selecting impacts may lead ancillary effects to be overlooked, something that is less likely with formal procedures such as cost-benefit analysis where the analyst is trained to look at overall effects. Rapid appraisal techniques are also less likely to accommodate the difference in the timing of costs and benefits. Overall, a guiding rule might be that the less formal the appraisal technique, the more likely it is that ancillary effects will not be fully integrated in policy analysis. Other concerns are that ancillary effects will tend to be local or regional (transboundary) whereas climate change is global. Those trained to analyse local effects may be less likely to exhibit a concern for global impacts. Finally, all formal procedures have the risk of displacing political authority. A good cost-benefit study will produce clear answers which could easily limit the flexibility of politicians to react in the way they wish.

Does the analysis point to any solutions? Probably the most important advance is that the use of formal procedures for policy appraisal is far more likely to account for ancillary effects compared to the use of ad-hoc and rapid appraisal techniques which still appears pervasive to decision-making. The introduction of guidance on regulatory impact appraisal – i.e. the formal appraisal of all regulations, as in the US and, increasingly in European countries such as the UK– would be a major advance.

4. Policy design and ancillary benefits

We take the design of policy to involve the means or instrument whereby a given target is achieved. It is convenient to divide policy design into three types of choice, acknowledging the reality that policies are increasingly involve hybrid mixtures of instruments:

4. the choice of overall policy stance which we characterise by the usual distinction between 'command and control' and 'market based instruments'[10] where we take the latter to include the emerging focus on voluntary and negotiated agreements;

5. the choice of instrument within the market based instrument 'menu' – e.g. taxes, tradable permits etc.;

6. the choice of mixes of instruments, e.g. taxes and negotiated agreements;

7. the choice between technologies if a command and control approach is adopted.

Probably the single most important feature of the ancillary effects discussion is that environmental policy needs to take far more consideration than it has done of the synergies between policies. Climate change policy, in particular, appears to have significant spillovers to other policy areas. Yet, until very recently, environmental control policies have tended to be focused on single targets. To take the example of the Convention on the Long Range Transport of Air Pollution (LRTAP), while the detailed analysis supporting the various Protocols has involved careful assessment of interactions between pollutants, the actual Protocols have tended to proceed pollutant by pollutant (SO_x, NO_x, VOCs). More recently, a multi-pollutant, multi-effect stance has been taken which recognises the interaction between control measures. To some extent, the target-setting procedure does account for climate control policies since the 'baseline' against which the target scenarios are compared includes a forecast of energy use. In turn, energy use is partially dependent on climate policies. Nonetheless, the procedures have not so far raised the issue of the 'best' mix of climate and pollution control measures.

[10] The distinction is to some extent artificial, but is useful for classificatory purposes here.

4.1 Command and control

While there has been moderate growth in the use of market-based instruments in OECD countries (OECD, 1989, 1995, 1999) most environmental policy remains rooted in 'command and control' (CAC) approaches whereby individual emissions sources are given some from of target or standard to achieve. Most of the standards relate to emission levels or to the abatement technologies employed. Climate change policy designed to comply with the Kyoto Protocol is still to be formulated in most OECD countries but the signs are that there will be a mix of CAC measures and market based instruments (MBIs). Hence we first consider CAC-type policies and the extent to which, as currently promulgated, they could account for ancillary benefits (and costs). We then consider MBIs and the ways in which they could account for ancillary benefits.

4.1.1 CAC: Technology-based standards

Technology-based standards tend to define the way in which most air pollution policy is formulated. A technology-based standard works by defining the 'best' technology for a given emission source and then requires that this best technology be adopted. 'Best' is defined in terms of the environmental impact. The terminology varies. In the USA the terminology is Best Available Control Technology (BACT) for new emission sources and Best Available Retrofit Technology (BART) for existing emission sources, both in Prevention of Significant Deterioration (PSD) zones, i.e. zones meeting or exceed national air quality standards. For non-attainment areas, i.e. areas where standards have not been met, new sources must meet the lowest achievable emission rate (LAER) and existing sources must meet a reasonably achievable control technology (RACT). Of relevance to the current discussion is that the US technology standards vary in stringency: LAER for new sources would be very stringent and RACT, for example, would be the least stringent. The gradations of stringency reflect the difficulties that emitting sources face in securing compliance – older plant would generally face higher costs than new plant in complying with a standard. In Europe a similar terminology is employed. Best available technology (BAT) is intended to refer to technologies that need to be introduced virtually regardless of cost. The term 'best available technology not entailing excessive cost' (BATNEEC) is reserved for technologies which are not the 'best' but which can reasonably be introduced given the costs of adopting technologies. The 'NEEC' part of the formula serves the same function as the 'R' in RACT in the US formulations.

The issue, then, is whether best or 'reasonably achievable' technology standards are consistent with consideration of ancillary benefits. In principle, BAT-type standards can be made consistent with ancillary benefit concerns in so far as ancillary benefits relate to associated emissions. The simplest way is to define 'best' technology as technology which achieves not only some defined carbon emission target but also other associated emission targets as well. In fact this is how BAT was defined within the UK context of environmental controls in the context of Integrated Pollution Control (IPC)[11]. The essential point, then, is that there is no presumption that BAT for climate-related regulations has to be confined to GHG emission levels. They already are sensitive to multi-media, multi-pollutant impacts.

Once the focus shifts from BAT to 'practicable' or 'reasonable' technologies, the scope for integrating ancillary benefits into technology based standards tends to decline. This is simply because such standards are less strict than BAT. Less environmentally efficient technologies will therefore be used and we can surmise that the more ancillary benefits are required to be taken into account, the more environmentally stringent the technology will become. Hence BAT is more likely to account for ancillary effects than 'reasonable' or 'practicable' technology standards.

The potential flexibility of the BAT regime can be illustrated by the current transition in Europe towards the implementation of the 1996 Integrated Pollution Prevention and Control (IPPC) Directive of the European Union. Under IPPC large combustion plants are subject to 'best available *techniques*' (which appears to be similar to BATNEEC in intent, but 'technique' suggests more flexibility to include, say, changes in management regimes as well as actual abatement technologies). But BAT in this context extends beyond emission standards ('emission limit values') to general requirements for waste minimisation and energy conservation. Thus, to some extent, IPPC will already 'integrate' multi-media impacts.

What of the other possible ancillary benefits such as technology-forcing and employment? Economic analysis usually suggests that BAT-style standards are not consistent with technology forcing since the emitting source simply has to comply by acquiring an 'off the shelf' technology which tends to be prescribed by the regulator. Unless the emitter can itself influence the choice of 'best' technologies, it has very little incentive to seek out even better than best technologies. A fairly simple modification of BAT-type regulations could overcome some of this problem by ensuring that BAT is defined by the regulator according to some 'menu' of available technologies, but leaving flexibility for emitters to demonstrate that there are even better technologies. The gain to the emitter should be that the even better technologies are cheaper. If they are not, then the emitter reverts to having no incentive to do better than BAT. Some BAT-type regulations, however, are set beyond what is currently achievable, i.e. the regulator deliberately engages in technology-forcing. On balance, the view that BAT is incompatible with technology forcing needs to be qualified by the potential for some incentives to do better than BAT, but the argument is perhaps not a very powerful one.

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11 IPC was concerned with regulating emissions so that consequent releases to all media – air, land and water – are accounted for. Authorisations for emitting sources are automatically given if the source meets the 'best environmental option' (BEO), i.e. the technology meets all the relevant standards. BEO is defined irrespective of the cost of the technology. BPEO (best practicable environmental option) arises when the cost of complying with the BEO is, in some sense, too high. Any emitter then has to justify the BPEO by reference to costs (the 'EEC' part of BATNEEC) and to an overall environmental benefit. In effect, some form of cost-benefit analysis is practised, although without the monetisation of benefits. In turn, environmental benefits relate to multiple media and, in principle, global warming impacts and, say, conventional pollutant emissions are included in the environmental benefits. Formal procedures for calculating such multi-media emissions into an Integrated Environmental Index (EIE) exist (HMIP, 1994).

Employment impacts are more complex. Interpretations of concept like BATNEEC vary (Pearce and Brisson, 1993; Pearce 2000). As we have seen, the relevant environmental impacts can be defined to be local, local and regional, or local, regional and global. The concept of 'cost' is also capable of differing interpretations. Typically, cost is taken to refer to the capital and operating costs of the abatement technology in question, i.e. the costs are firm-based. Nonetheless, since the technology that is 'acceptable' to regulators is determined virtually on a site-by-site basis, the employment impacts of different technology choices is a relevant consideration. Indeed, it is clear that negative employment consequences arising from compliance costs being significant are regarded as an additional component of 'excessive' cost. However, in this context the concern is with BAT as something that is likely to reduce employment rather than enhance it. Could the potential for employment creation be regarded as part of a GHG-BAT standard? BAT is, by definition, implemented on a plant by plant basis. Hence the likelihood that a 'best' GHG technology at the level of the single plant simultaneously achieves some desirable GHG emissions target, ancillary emissions reductions, and employment benefits seems rather small.

So long as technologies or available, or achievable in the near future, that secure specified gains in GHG emissions and in ancillary pollutants, there appears to be no major obstacle to integrating ancillary benefit concerns into technology-based standards. Virtually by definition, the scope for doing this is reduced the greater is the relaxation of the technology to being one that is 'practicable' or 'reasonable'. The scope for technology forcing under technology-based standards is not perhaps as limited as is often suggested, but there clearly are problems of securing major ancillary gains on this front with such standards. The employment issue is more complex since the chances that prescribed technologies will secure employment gains within the firm do not seem very high.

4.1.2 Ambient and emission standards

Increasingly, environmental policy is moving towards ambient and emission standards, including standards that are set within the context of agreements between governments and polluters. In principle, standard setting should be informed by an analysis of all the costs and benefits accruing from the standard, whether the costs and benefits are monetised or not. On the 'fixed coefficients' approach, any standard set for a non-greenhouse gas pollutant would result in reductions in greenhouse gases, or at least CO_2. The fixed coefficient approach is not always appropriate however. If a standard is set for sulphur oxide emissions reduction from electricity generation, and that reduction can only be achieved by adopting flue gas desulphurisation equipment (FGD), then one effect is to reduce power station efficiency and increase CO_2 emissions. In this respect, standard setting is more flexible that the technology-based approach (which might have prescribed FGD) because it leaves the polluter to choose how best to meet the standard. But in other respects, standard setting militates against consideration of multi-pollutant effects, and hence ancillary effects. This is because the standards tend to be set pollutant by pollutant. It is important, therefore to set standards on a multi-pollutant basis.

The issue can be illustrated with the 'CAFÉ' standards in the USA. The Corporate Average Fuel Efficiency (C.A.F.E) standards date back to 1975 and the US Energy Policy and Conservation Act. Standards were set for passenger vehicles and light trucks in terms of future targets for fuel efficiency expressed in miles-per-gallon. The standards were set in the wake of the early 1970s OPEC oil price hike and hence had no particular environmental motivation Harrington, 1996). Since the standards appear to have been about twice as effective in improving fuel efficiency as the accompanying fuel price increases due to crude oil price rises (Greene, 1990), the subsequent issue became one of seeing if further efficiency targets had an environmental justification. Di Figlio *et al.* (1990) suggested that a standard of around 34 miles per gallon (mpg) could be justified on the basis of gasoline *cost savings alone*. The actual standard that had been set for 1985 was 27.5 mpg for passenger cards[12]. Thus, a nearly 25% increase in efficiency could be achieved on a *financial no regrets* basis: financial costs would be equalled by financial benefits and no vehicle performance penalty would be incurred. Once environmental benefits in the form of reduced vehicle emissions (NO_x, VOCs, CO_2 etc) are added to the financial gains, there is the potential for raising the standard further. As it happens, the links between fuel efficiency and emissions is not straightforward in the US case because emission standards also exist for vehicles. But Harrington (1996) shows that the older the vehicle, the closer does fuel efficiency approximate emissions efficiency. The link is virtually non-existent for modern vehicles but very close indeed for vehicles ten years old. But the linkage is itself complex since the age-emissions relationship has more to do with the failure of emissions control systems on older vehicles than with fuel efficiency as such.

The example illustrates several features of standard setting. First, standards are usually set according to a single goal, say an ambient quality standard thought to be consistent with acceptable health or ecosystem effects, or, in this case, some notion of saving on oil import costs. Second, consideration of all the benefits of a standard – in this case the environmental benefits are the ancillary benefits – could easily result in a stricter standard. Third, in practice complex interactions have to be accounted for. In the CAFÉ case, the presence of a different standard, on vehicle emissions, qualifies the presumption that more fuel efficiency results in more emissions reduction. This observation holds for any context where the ancillary emissions are already subject to some form of limit that must be achieved anyway. In such contexts, however, there may be scope for saving on control costs. The central point is that a failure to incorporate ancillary benefits (and costs) into standard setting *adds* to the inefficiency which many economists believe resides in standard setting[13]. If better solutions cannot be chosen for some reason, it is at least incumbent on regulators to set standards on a multi-effect basis.

4.2 Market-based instruments

The two most widely advocated MBIs for dealing with GHG reduction are (a) carbon/energy taxes and (b) tradable permits/joint implementation.

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12 By 1988 actual fuel efficiency was about 28 mpg, but it subsequently fell back to some 25 mpg.

13 i.e. the cost inefficiency of standards relative to market based instruments.

4.2.1 Carbon/energy taxes

Despite significant lobbies against carbon or energy taxes, some eight countries in the EU-15 group of countries already have, or plan to have, such taxes. While taxes on energy that do not discriminate between the carbon content of fuels are clearly inefficient as GHG –reducing taxes, some countries have felt unable to introduce 'pure' carbon taxes. Various factors account for this. Practical difficulties are cited in some cases, but in others it is clear that concerns over employment effects in one or other of the fossil fuel supply industries have led to 'blanket' taxes being introduced on all fossil fuels. In these contexts, how should ancillary effects be accounted for?

The theoretical answer is comparatively simple and is illustrated in Figure 3. The horizontal axis shows increasing levels of GHG abatement. The marginal global benefit function is assumed to be downward sloping and, for convenience, the marginal ancillary benefit function is assumed to be constant. Thus MGB + MAB defines the total benefits that result from an individual country's decision to abate GHGs. The marginal control cost function, MCC, is assumed to be increasing in GHGs. The 'optimal' tax would have been t in the absence of consideration of ancillary benefits, but becomes $t^* > t$ once ancillary benefits are accounted for. Effectively, then, the relevant carbon/energy tax is higher once ancillary benefits are incorporated.

One complication is that the ancillary effects will usually be the subject of separate policies, e.g. to reduce acidification and eutrophication from NO_x, SO_x, NH_4 and VOCs, to reduce noise nuisance and traffic congestion etc. If the marginal costs of controlling these effects are lower than the marginal ancillary benefits illustrated in Figure 3, then the relevant increment to the carbon/energy tax is given by the avoided control costs rather than the damage costs[14]. Various studies of European policy on the control of conventional air pollutants suggests that marginal benefits exceed marginal control costs for further ranges of controls, despite the considerable advances already achieved by policy (AEA Technology, 1999). These results are, however very sensitive to assumptions about the 'value of statistical life' which tends to determine the size of the health benefits accruing from pollution control. If this result was a general one, i.e. all ancillary effects exist at levels below their optimal control, then integrating ancillary benefits into tax design is simpler since it would not be necessary to estimate the ancillary benefit function. All that is required is some knowledge of the abatement cost function for the direct regulation of ancillary effects.

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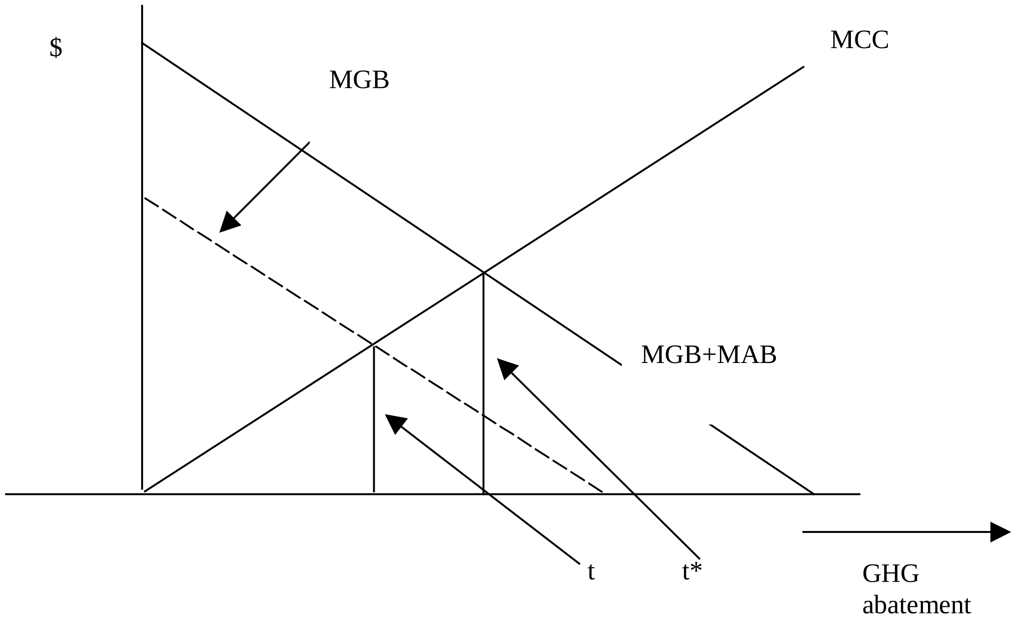
[14] This point is noted in Ekins(1995, 1996) but Ekins deducts the benefits from GHG control costs. Didactically this obscures the fact that the carbon tax has to increase since the relevant tax still relates to the original abatement cost curve.

Figure 3. **Carbon/energy taxes with ancillary benefits**



Ekins (1995, 1996) also notes that as abatement technologies for addressing ancillary effects improve, so the ancillary benefit credited to GHG control (i.e. the avoided control costs of ancillary effects) will decline. Whether this effect occurs depends on the extent to which the measures that would be taken to control ancillary effects are themselves 'technology forcing'. Comparatively little evidence exists on this issue, as was noted in Section 2.4.4 above.

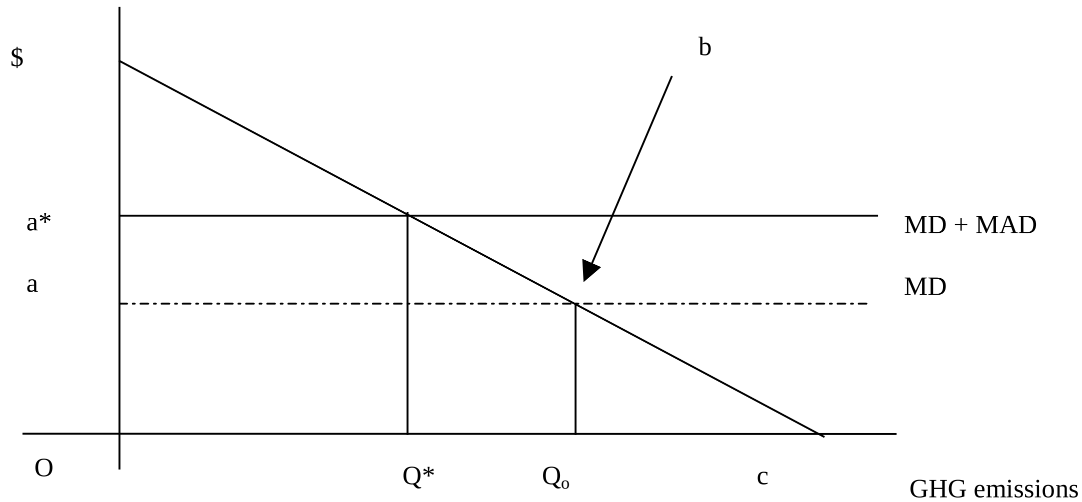
There are several reasons why carbon taxes should not be modified to reflect ancillary effects, however. First, carbon taxes are designed to meet given targets such as those agreed under the Kyoto Protocol. Varying the tax downwards if there are ancillary costs would make the targets more difficult to achieve. Raising the tax would result in 'overcompliance' which could be counterproductive if lobbies chose to campaign against the Kyoto targets. Second, ancillary effects are best seen as an added reason in support of carbon taxes (the standard cost-minimisation arguments would perhaps be the main supporting argument). Since such taxes tend to be unpopular, it is beneficial to have a number of rationales for the tax.

4.2.2 Tradable permits/joint implementation

Just as a carbon tax that accounts for ancillary benefit should be higher than a 'GHG alone' carbon tax, so the quantitative target set for tradable permits allowances should be stricter once ancillary benefits are allowed for. The essence of the picture is shown in Figure 4. In this case GHG emissions are shown on the horizontal axis, so that control is read from right to left. MCC is the marginal abatement cost curve and Q_o is the initial allocation of permits. The ruling price of permits is given by the intersection of the vertical supply line through Q_o and the MAC curve. The emitters are required to purchase from the environmental regulator a Q_o permits at a cost of $OabQ_o$. This sum is a transfer between emitters and the regulator so no real resource cost is involved. In the absence of policy, emitters would emit Oc tonnes of GHGs. Since they can only emit Od, the triangle $Q_o cb$ represents the aggregate abatement costs they incur.

MD is a marginal global damage curve (the mirror image of the marginal benefits curve in Figure 3) and this is shown as constant, just for convenience. Any reduction in emissions therefore saves MD for each tonne of emissions reduced. The optimal level of emission reduction is therefore cQ_0 which we show as being coincident with the result achieved by issuing Qo permits. If we also assume ancillary costs are a constant fraction of MD, then the MD + MAD (marginal ancillary damages) curve becomes the relevant curve for policy. Instead of Q_o permits being issued for optimality, only Q* permits should be issued and the effective permit price should be a* not a. The result is the dual of the carbon tax case since, in the simplest case, optimal carbon tax and optimal permit price will be the same.

Figure 4. **Effects of ancillary benefits on tradable permit issues**



Of more significance for tradable permits is the effect of ancillary benefits on the distribution of the permits between emitters. Since GHGs are uniformly mixed pollutants the exact location of sources of emissions is immaterial to GHG policy. Ancillary effects are, however, location specific, so that the location of GHG reductions does have an effect on the overall benefit secured. From the emitting country's point of view, the optimal location will be one where the net aggregate benefits of control are maximised. Thus the implications for policy could be considerable since, provided ancillary benefits are significant, it would mean geographically targeting GHG control. One implication could be that GHG control would be best targeted in well populated areas where ancillary benefits per tonne of GHG reduced are likely to be highest. However, the added complication is that abatement costs will vary from one location to another even inside a single country (Bohm, 1997). Hence, per dollar spent, it is the net ancillary benefits that need to be maximised.

The geographical sensitivity of ancillary benefits thus affects trading regimes[15]. Two firms in different locations trading in carbon will affect the damage from ancillary pollutants. If firm A is responsible for higher damages per tonne of, say, SOx released, and firm A is the buyer of GHG permits, then the trade will result in higher ancillary costs than would otherwise be the case. The options, broadly, are to ignore these ancillary effects, or to build them into the trading regime as a restriction. An example of the former outcome occurs with the one-to-one trading in SOx under the US Clean Air Act. Emitters can trade SOx permits even though this may result in damage to a third party who is not part of the trade. This opens the way for legal suit against the parties trading. The alternative is to regulate the trades in emissions in such a way that certain deposition targets must be met (Krupnick *et al.*, 1983; McGartland and Oates, 1985; Tietenberg, 1985). Indeed, such rules are implicitly built into the 1994 Second Sulphur Protocol of the LRTAP governing emissions control in the wider Europe. The rules were designed precisely because cross- boundary sulphur trades might have third country effects[16].

It is not clear, therefore, how far sensitivities over the ancillary effects of carbon trading will affect the development of these trades. It is not just the localised ancillary affects that matter but the transboundary effects of pollutants such as SO_x and NO_x. The fact that no Party to the SSP has so far notified the UNECE of any intention to enter into such trades suggests that, in Europe anyway, such sensitivities are high over sulphur trading and, ergo, may therefore similarly become high for carbon trading. Klaassen (1996) and Bailey et al (1996) show that the potential for cost-saving sulphur trades is very modest once deposition constraints are imposed. Potential solutions involve the creation of 'exchange rates' between sources, so that 1 unit of SOx in location A could only be traded for X units in location B where X is not equal to 1. But exchange rate systems for sulphur are acknowledged to be administratively very complex and would also probably be controversial. Having an exchange rate system for a carbon trade to reflect not just sulphur but NO_x, VOCs and even PM would be extremely difficult to imagine.

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15 It also affects taxes in that optimal taxes will also vary by location once ancillary effects are accounted for. The political sensitivity over the regional impacts of trading regimes appears to be higher (in Europe) than over regional impacts of taxes for reasons that are not entirely clear.

16 The relevant wording of the SSP changed from explicit reference to requiring that 'environmental improvements for third Parties are not compromised' to requiring that any trades be consistent with the basic obligations on emission reduction and environmental improvements. See Article 2.7 of the Second Sulphur Protocol.

Because trading in carbon has only just commenced on a modest scale in Europe it is too early to say whether the ancillary effects issue will enter into the design and regulation of the trades[17]. Those trades that are taking place – mainly within single companies or between companies within the same sector – appear not to have been influenced by the ancillary effects issue. The most probable reason for this is that the regulations governing ancillary pollutant emissions are strictly binding, i.e. the carbon trades are effectively already constrained by specific regulations on the ancillary pollutants. If so, the potential problems of carbon trades giving rise to adverse ancillary effects will not arise. Indeed, those designing nascent carbon trading regimes have already warned that it is the restrictions on site-specific pollution emissions under Integrated Pollution Control that threaten the potential for carbon trades (Emissions Trading Group, 1999). But, of course, reduced trading could secure ancillary benefits in the sense of 'beyond compliance' gains in reduced ancillary pollutants.

4.2.3 Voluntary and negotiated agreements

The emergence of 'hybrid' policy instruments centring on some form of agreement between polluters and government is one of the most interesting policy developments in recent years. While terminology varies, Börkey and Lévêque (2000) make a useful distinction between *unilateral commitments, negotiated agreements,* and *public voluntary agree*ments. A unilateral agreement involves a polluter declaring some commitment, e.g. a 5% energy reduction target, a given emissions reduction target, without the involvement of any public authority. A negotiated agreement involves a commitment that is the outcome of a bargain between polluter(s) and government. A public voluntary agreement involves a public commitment, e.g. by a regulatory agency, to which individual firms are invited to participate.

Baeke *et al.* (1999) show that PVAs are most common in the USA, whilst negotiated agreements are most common in Europe. Space forbids a more detailed classification but each category has within it various features which vary according to the individual agreement. Thus, agreements may be *target-based* such that, if targets are met, some alternative regulatory threat is not implemented; *performance based* and primarily aimed at realising unanticipated cost savings and securing 'green image'; and *co-operative R&D* where government and polluter share the cost of R&D to improve environmental performance. Schemes also vary according to the degree of public involvement, the nature of financial incentives, the sharing of information and so on. For full details see Baeke *et al.* (1999), Mazurek (1998, for the USA), Imura (1998, for Japan) and Börkey and Lévêque (2000, for the European Union) and OECD (2000, for OECD generally).

[17] World-wide there are around 200 carbon trades dating from the first in 1989. These trades have taken place before the Kyoto Protocol and are not part of the Protocol. Within-firm trades have commenced in the UK in the oil sector.

Another feature of voluntary and negotiated agreements (VNAs) is that they can be linked to other policy instruments. The most obvious way is through a tax as a threat mechanism, but the threat could take any regulatory form, e.g. tighter land use controls, emissions or ambient or technology standards etc. This type of arrangement tends to define negotiated agreements. An example would be the impending Climate Change Levy (CCL) in the UK which is essentially an energy tax, 80% of which can be avoided by implementing an industry-wide package of measures ranging from energy efficiency improvements through to absolute carbon dioxide reduction targets. More subtly, the market instrument may be one of the mechanisms included in the package of industrial measures. Thus there are signs that the CCL regime, when introduced, will be accompanied by within-industry permit trading with any gains from trade being regarded as tradable against the package of environmental obligations.

How, then, would ancillary benefits fit into such mechanisms? Allowing for the fact that the agreements vary enormously in their precise attributes, the general answer must be that such agreements are ideally suited to the inclusion of ancillary effects. First, if the agreement is entirely unilateral, it is open to polluters to declare that their targets include not only greenhouse gas reductions, but ancillary emission reductions as well. Providing the ‘fixed coefficients’ model pertains –i.e. ancillary emissions are proportional to GHG emissions – industry would in effect be claiming credit for something that would happen anyway, i.e. the ancillary effects are ‘free goods’. Nonetheless, it is easy to envisage a gain in ‘green image’ from such a tactic. In the event that the fixed coefficients model does not pertain, more complex trade-offs would have to be made so that some ‘optimal’ mix of emissions reductions is secured. Second, if the agreement is a negotiated one, it is open to government or regulator to include ancillary effects in the package of measures required from industry. The advantage of this would one of ensuring that packages are not negotiated in such a way that ancillary *costs* arise. That is, focusing on ancillary effects in this case amounts to no more than a rational assessment of any package of measures that is advanced by either side. The importance of appraisal mechanisms that ensure this needs emphasis here. Third, many agreements involve internal levies on firms with an industry. The levies may be used for all kinds of purposes but one could well be to advance R&D into further abatement measures, thus stimulating technological development and future primary and ancillary emissions reduction. An alternative would be for government to return some of the revenues from that part of a threatened tax that is actually paid, so as to finance R&D. There are virtually endless possibilities.

Integrating ancillary benefits into VNAs appears unproblematic. The debate surrounding VNAs is in fact a different one, namely whether they are effective or not. First, the emergence of VNAs is partially explained by concerns over the compliance costs of CAC approaches and the difficulties of designing MBIs to replace the traditional regulations. Second, VNAs openly address the issue of asymmetric information, i.e. the view that regulators have only imperfect understanding on the least cost control mechanisms, information that mainly resides with the polluter (Krarup, 1999). Third, and developing the second point, VNAs encourage the sharing of information among firms within a given industry and, ultimately perhaps, between industries. This reduces compliance costs once ‘best practice’ is identified. This information sharing will occur provided there are few gains from withholding information, which is always a risk. Regulatory costs are similarly reduced. Fourth, there is a potentially significant role for consumer or environmental groups to influence the process, something that can happen only very indirectly with other policy instruments. Interest groups may, for example, help design the package of measures.

Doubts arise from a number of issues. First, as noted, firms may behave strategically with respect to the provision of information setting up barriers to competition rather than reducing compliance costs. This is one of the risks of having the polluters initiate the package and it requires a strong regulator to ensure that these risks are avoided. Second, VNAs are new and the risk of failure is high, where failure can be measured in terms of targets not met or cost reductions not secured. Risks arise from several sources. Firms may well prefer VNAs because it gives them the initiative and they can then lobby the regulator to agree with their stance – a kind of 'regulatory capture'. Similarly, unless the threats contained in negotiated agreements are activated, or polluters are persuaded they will be activated, there may be a low incentive to comply. And designing packages of measures that contain the right incentives is complex: some VNAs, for example, involve managers achieving environmental management goals which are not linked to actual environmental improvements or to any reward mechanism for achieving the management standard. For these reasons, and many more, quite a few commentators have expressed serious reservations about the effectiveness of VNAs (Nunan, 1999; Bizer and J•lich, 1999). The only real conclusion is that they hold great promise but that some elapse of time is required to see how well they work. As far as climate change ancillary effects are concerned, however, VNAs have more than sufficient flexibility for them to be integrated into the relevant policy package.

4.3 Choosing between technologies

Choices between technologies (as opposed to abatement technologies now) can be influenced by CAC and MBI measures. We can illustrate with respect to fuel technologies, but the principles are the same for other technologies. Fuel choice is known to be sensitive to price and to direct regulations. How far can regulations on fuel use reflect the concern with ancillary benefits? A good example of the problems is the choice between fuels for goods vehicles. Considerable debate now surrounds the use of diesel fuels versus the choice of compressed natural gas (CNG) and gasoline. Toy *et al.* (2000) suggest that the environmental advantages and disadvantages appear as follows:

Criterion	Diesel	CNG
Fine PM		✓
Ultra-fine PM	?	?
NO_x		✓
GHGs	✓	
Safety	✓	
Performance	✓	
Cost	✓?	?

Eyre et al (1997) estimate emission factors for vehicles in the UK and find that CNG and diesel are approximately the same in terms of CO_2. Once upstream fuel cycle activities are included, however, CNG is moderately worse than diesel. If we imagine a carbon reduction policy aimed at fuel choice, the balance may be in favour of diesel. But such a choice would have a significant cost in terms of particulate matter emissions which are known to have serious health impacts. In other words, we have an example of *ancillary costs* rather than ancillary benefits. Targeting technology choice for fuels in terms of a single goal – CO_2 reduction - could therefore be counterproductive. Indeed, Eyre et al (1997) show that, using willingness to pay weights for the damages[18], CNG is very clearly the preferred fuel in the damage cost ratios gas=1, gasoline = 2.5 and diesel = 3.5. The fundamental conclusion is that climate change policy, just like any other policy, need not be a case of 'win win'. There will be trade-offs and hence there is a need for risk assessment methodologies to handle those trade-offs. In the Eyre *et al.* analysis the methodology involved is monetary benefit assessment.

The above example can be generalised to other potential contexts where GHG control policy may have the effect of creating ancillary costs. OECD (1999), for example, cites gas-based cogeneration in urban areas where NO_x increases may result, and the use of nuclear power as a GHG control technology where radiation risks may be involved. Obversely, switches from coal to gas power electricity are likely to yield ancillary benefits. In principle, such comparisons can all be analysed using risk assessment procedures, including cost-benefit analysis.

4.4 Conclusions on ancillary benefits and policy design

This section has sought to determine whether there are inherent obstacles to the integration of ancillary benefits analysis with the existing modes of environmental policy in OECD countries. As far as conventional 'command and control' measures are concerned, technology-based standard setting tends to dominate. This has been strengthened in recent years by the moves towards integrated pollution control where multi-media effects are accounted for. Close inspection of the ways in which 'BAT' and 'BATNEEC' standards are formulated shows that there should be little difficulty in incorporating ancillary effects into those standards. The reason for this is that the standard setting does often involve multi-pollutant analysis. Thus the development of Integrated Pollution Prevention Control (IPPC) in Europe involves energy conservation standards which already therefore account for multiple pollutants from energy sources. In the UK, the principle of 'BATNEEC' already involves multi-pollutant effects.

[18] Willingness to pay weights are monetary measures of environmental damage expressed in money units per unit weight of the pollutant. These weights are derived from the numerous studies of 'externality adders' in Europe and the USA.

As far as carbon/energy taxes are concerned, these have already developed quite rapidly within the EU Member States. Ancillary effects could in principle be incorporated by raising the tax rate (if ancillary benefits exist) or lowering it (for ancillary costs). Since the taxes are likely to be only one instrument among a 'bundle' of instruments for achieving Kyoto targets or targets under the EU burden sharing agreement, there appears to be flexibility in tax policy to achieve this effect. However, there are currently no signs that ancillary benefits analysis has been an integral part of carbon/energy tax design. To a considerable extent this is likely to be because the size of the tax cannot be determined by environmental impacts alone. Perceptions about cost burdens, competitiveness and equity impacts tend to dominate the politics of carbon taxes. As such the tax measures that have been developed, or are being proposed, in OECD countries bear little resemblance to the 'optimal' tax design of economics textbooks. An additional reason for not being concerned with ancillary effects will be the belief that many of these effects, particularly the most studied ones of conventional pollutants, are already well managed by other environmental initiatives.

One of the most promising contexts for integrating ancillary effects into policy packages is through voluntary and negotiated agreements. These VNAs have wide flexibility as to what is included and polluters can readily gain by counting ancillary effects as 'extra' gains from a greenhouse gas target and regulators can easily request that ancillary effects are included. In other words, VNAs have more 'opportunity' for including ancillary effects compared to other policy instruments.

Finally, tradable permit and joint implementation regimes could take account of ancillary benefits and costs (a) through the initial decision on quota issue, and (b) through trading rules that safeguard third party interests. It was suggested however that third party effects, which are perceived as being important in the European context, would be very difficult to integrate into a trading system. This partly explains why the existing sulphur trading regimes do not adopt such safeguards. Again, the belief may be that such safeguards are not required because the relevant pollutants are in any event strictly controlled. Such controls may, however, have the effect of limiting the extent to which carbon trading can take place.

As far as forms of joint implementation are concerned, they too will have third party effects via the interaction with conventional pollutants. In OECD-Europe this may be especially important with respect to any carbon trades between Western and eastern Europe. Trades with developing countries via the Clean Development Mechanism could have deleterious effects on conventional pollution in the investing nations.

5. Conclusions and Recommendations

This paper has had as its main focus the issue of integrating ancillary effects into climate change policy initiatives. From this overview certain conclusions and recommendations can be derived.

1. <u>'Demonstrate' the importance of ancillary effects</u>

Chapter 2 briefly surveyed the estimates of ancillary benefits of climate control policies. There is a very wide range of estimates. Differences would appear to be due to differing methodologies, and different assumptions about 'policy in the pipeline' as far as air pollution control is concerned. Nonetheless, even accounting for these differences, the impression remains that ancillary benefits could be comparable in size to the 'primary' (global warming) benefits. If so, there is a need to demonstrate these benefits on a more substantial scale. There is little evidence that such concerns have informed existing climate change policies in OECD countries and the ancillary benefits literature has remained largely academic to date (the OECD initiative being the first to broaden the debate).

2. <u>Clearer definition of what ancillary effects are and how they should be presented</u>

Section 2.4 noted that most of the literature on ancillary effects concerns air pollution and a significant part of this literature involves monetary estimates. It could be argued that monetisation both helps and hinders the 'cause' of integrating ancillary effects into climate change policies. It should help because it permits direct comparison of the benefits with monetary damage reduction from GHG emissions or with estimated carbon taxes. It may hinder the process if there is hostility towards monetary benefit estimation (see Annex 2 for an overview of the issues). A case can be made for presenting ancillary effects in terms of percentage changes from a baseline, or in terms of probable life years saved, or similar indicators.

The picture is also made more obscure by the inclusion of employment and 'technology forcing' effects as ancillary benefits. It is far from clear than climate policies, however formulated, will generate gains in employment, but some models do show this result. More of an issue is the extent to which such effects should be included at all. Section 2.4 notes that it may result in double counting if 'full welfare analysis' has been pursued. The literature on technology forcing is very limited and Section 2.4 suggests that what matters in this context is the extent to which climate change policies induce technical change in sectors that are not directly targeted.

3. <u>Play the 'no regrets' card</u>

Chapter 3 observed that some climate policy will have 'no regrets' features. Definitions of no regrets policies vary from policies where there are actually negative financial costs, through to those that are justified only when ancillary benefits are included. Some economists query whether there really can be negative costs for policy since one would expect the economic system to have taken up those options already. But there is evidence to suggest that information flows and management issues often inhibit the full exploitation of profitable opportunities. Hence no regrets contexts need to be explored thoroughly.

Ancillary benefits can also justify acceleration of climate policies since the ancillary benefits are likely to occur in near time whereas climate change benefits will accrue much later.

4. Use cost benefit approaches where credible

Chapter 3 noted that the cost-benefit paradigm has the potential to account for ancillary effects by simply adding (or subtracting) them from estimates of the primary benefits (i.e. the monetary value of avoided warming damages). As long as the estimates are credible, then, cost-benefit should be used. This is especially important if the primary benefit figures appear not to be supportive of aggressive climate policies since the addition of the ancillary benefit figures could perhaps double the primary benefits. This conclusion is subject to the caveat about the wide range of available estimates of ancillary benefits. Annex 2 explores some of the debates about benefit estimation. It is perhaps especially important to note the debate over the validity of 'benefits transfer' since it is this technique that has been used so far in estimating ancillary benefits in terms of reduced air pollution. Explaining opposition to cost benefit would have to be the subject of a separate exercise, but it does need emphasising that this approach is used to very different extents within OECD countries.

5. Use rapid appraisal

Antipathy to the more formal procedures of integrating ancillary effects into policy appraisal may mean that some form of 'rapid appraisal' is required. This may be as simple as checklists of likely ancillary effects, or as complex as some form of decision matrix incorporating best available physical estimates of effects. Section 3.4 noted that even these approaches may be difficult in the face of perceptions that what is being integrated are impacts with very different time periods of concern, very different levels of uncertainty and very different solutions (technological versus behavioural change). It is here perhaps that major research effort is required into methodologies for presenting such different impacts together. Ultimately, the 'reductionist' approaches such as risk assessment and cost benefit analysis may still be best, but the issue needs more research effort. Arguably, beginning with rapid appraisal can lead on to more formal techniques being used. The risk in using rapid appraisal first is that it becomes the 'norm' and there will be resistance to developing it further. As the text noted in several cases, only formal techniques hold out the firm promise of accounting for ancillary benefits due to the discipline involved in identifying costs and benefits.

6. Ensure that standard setting reflects ancillary benefits

As far as conventional environmental policies are concerned, technology-based standard setting tends to dominate. 'BAT', 'BATNEEC' and integrated pollution control standards are formulated in such a way that it should be possible to incorporate ancillary effects into those standards. Indeed, in some cases they already are built in to the ways the standards are operated in practice.

There may be more problems in the context of emissions and ambient standards because these are often set pollutant-by-pollutant. There are signs that 'multi-effect' approaches to standard setting are emerging but the historical record has traditionally not taken this route.

7. Give attention to the role of ancillary effects in carbon/energy tax design

Section 4.2 showed that, in principle, the existence of ancillary effects could be used to redesign carbon/energy taxes to reflect ancillary effects. Carbon taxes could be higher if there are ancillary benefits and lower if there are ancillary costs. However, there are arguments that militate against modifying taxes in this way. First, carbon taxes are designed to meet given targets such as those agreed under the Kyoto Protocol. Varying the tax downwards if there are ancillary costs would make the targets more difficult to achieve. Raising the tax would result in 'overcompliance'. Second, ancillary effects are best seen as an added reason in support of carbon taxes (the standard cost-minimisation arguments would perhaps be the main supporting argument). Since such taxes tend to be unpopular, it is beneficial to have a number of rationales for the tax.

There is currently no evidence to suggest that ancillary benefits analysis has been an integral part of carbon/energy tax design in those countries that have developed such taxes. To a considerable extent this is likely to be because the size of the tax cannot be determined by environmental impacts alone. Perceptions about cost burdens, competitiveness and equity impacts tend to dominate the politics of carbon taxes. As such the tax measures that have been developed, or are being proposed, in OECD countries bear little resemblance to the 'optimal' tax design of economics textbooks. An additional reason for not being concerned with ancillary effects will be the belief that many of these effects, particularly the most studied ones of conventional pollutants, are already well managed by other environmental initiatives.

8. Take advantage of the flexibility of voluntary approaches

Voluntary and negotiated agreements are ideally suited to ancillary benefits analysis because of their flexibility. Where the package of measures is initiated buy corporations, ancillary effects can be claimed as 'extra' benefits of the package, even if they are automatic free goods because of a fixed relationship of the emissions with GHG emissions. Where the package originates with, or is developed by, regulators, appraisal techniques should be used to ensure that the package accounts for ancillary effects. Guidance on appraisal techniques is generally issued in the form of handbooks and guidelines by most governments and regulatory agencies.

9. Monitor the ancillary effects of carbon trades

Chapter 4 noted that tradable permits and joint implementation in carbon could have third party effects in terms of ancillary pollutants. It was suggested however that third party effects, which are perceived as being important in the European context, would be very difficult to integrate into a trading system. Additionally, there is a belief that third party safeguards are not required because the relevant pollutants are in any event strictly controlled. Such controls may, however, have the effect of limiting the extent to which carbon trading can take place.

As far as forms of joint implementation are concerned, they too will have third party effects via the interaction with conventional pollutants. In OECD-Europe this may be especially important with respect to any carbon trades between Western and eastern Europe. Trades with developing countries via the Clean Development Mechanism could have deleterious effects on conventional pollution in the investing nations.

The complexities associated with carbon trading arise because what is being jointly produced is a uniformly mixed pollutant (carbon) the location of which does not matter in terms of warming damage, and a local and transboundary pollutant the location of which does matter.

10. Accept that there will be trade-offs

While it is tempting to think that many environmental policies have 'win win' features, the reality is that most do not take this form. There are losers. Section 4.3 looked more closely at one example: the choice between vehicle fuels. It was noted there that diesel might be a preferred fuel if the only concern is CO_2, but diesel becomes a distinctly inferior fuel once all impacts are accounted for and monetary (willingness to pay) weights are applied.

11. Press for 'joined up' government

The principles of sustainable development require that environment be integrated into all social and economic policy, whatever its nature. The practice is a long way from this goal simply because regulatory agencies and government departments have their own goals and their own bureaucracies. They are not necessarily 'social welfare maximising' entities. Nonetheless, some progress has been made, e.g. by issuing environmental guidance to non-environmental departments, by designating individuals in different departments to be 'responsible' for environmental concerns and so on. This 'greening of government' opens up more possibilities for securing a holistic look at individual policies. But just as there are obstacles across separate departments, so there are obstacles within a single environmental agency or department. Those responsible for climate change policy may be quite separate from those who are responsible for air pollution or traffic control, for example. Communications between divisions involves transactions costs for individuals who tend already to be fully stretched by the demands of policy. Indeed, 'time to reflect' often seems to be missing within operational departments and agencies. The aim of 'joined up' government is to reduce these transaction costs and to get decision-makers to think holistically. The forces inhibiting the 'joining up' are formidable, but the pressure needs to be maintained.

ANNEX 1. SIMPLE ANALYTICS OF ANCILLARY BENEFITS

Suppose there is a climate change target which, if achieved, would result in (global) benefits of Bg and costs to the emission-reducing nation of Cd. Bg here refers to the *avoided global warming damage* at the global level. Assuming that the emission-reducing country is acting because of its global concerns, it will be more inclined to take the requisite action if Bg > Cd and less inclined if Bg < Cd. Any given policy mix of measures to reduce greenhouse gas (GHG) emissions will also secure a given set of ancillary benefits (Ad). Including these benefits could alter the decision to abate GHGs since the relevant calculation is now [Bg+Ad] > or < Cd.

Some of the ancillary benefits may arise 'necessarily' because, whatever the policy measure, the action of reducing GHGs reduces jointly produced pollutants. Thus, a policy targeted at large combustion plant emissions would certainly reduce other pollutants depending on the 'end of pipe' technologies already in place. Other ancillary benefits will be instrument-dependent, i.e. they will depend on the *policy design*. Reductions in road traffic in order to control CO_2 could therefore reduce traffic noise, congestion, vehicle emissions, severance etc. But a policy aimed at reducing GHG emissions from road traffic that focused on, say, fuel efficiency, would not reduce congestion or severance and may not reduce noise nuisance either. Hence Ad above consists partly of a 'fixed coefficients' element (Ad,f) and an element that is a function of policy design (Ad(M)). The aim of GHG policy could therefore be one of selecting GHG emission reduction targets and policy design so as to maximise the net benefits of control:

Max (Bg + Ad,f + Ad(M) – Cd).

Given the difficulties of any one country setting a unilateral target, the problem could be reformulated as one of choosing a policy design so as to minimise the overall social costs of achieving a given GHG reduction target, i.e.

Min {Cd – (Ad,f + Ad(M)} for some given GHG target.

Care has to be taken to ensure that the costs of securing ancillary benefits are less with the targeted GHG policy than they would be if there was a policy specifically targeted at securing the ancillary benefits. Thus, if, say, there are benefits arising from reduced acidification due to lower acidification gases, what matters if that the costs of achieving those benefits is less than the costs of achieving them via a targeted anti-acidification policy. This may seem like a redundant caveat since the costs of securing ancillary benefits via a GHG policy are effectively zero. But just as it is theoretically possible to have a 'negative cost' policy for GHG reduction so it may also be possible to have a negative cost policy for acidification reduction.

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