

Taxes and Trading -

The Best Way to Reach
Environmental
Emissions Targets

Bridget Rosewell
Volterra Consulting

**This report was published by Volterra Consulting
PO Box 24299, London SE12 0ZR**

© Copyright Volterra 1999

ISBN 0 9535816 0 8

Foreword

This report was prepared by Bridget Rosewell of Volterra Consulting. I am grateful for the support of BP Amoco in financing the research and allowing access to their own material. I am also grateful for the assistance of Professor Nick Morris of City University Business School.

The opinions expressed here, however, are those of the author and are not necessarily those of BP Amoco.

Volterra Consulting is a economic consultancy which applies innovative techniques and solutions to business questions. For more information about this report please contact Volterra on +44 (0)7071 880 828.

Contents

1	Overview	1
2	Background and Purpose	6
3	Lord Marshall & BP Amoco's scheme	8
4	The criteria for a successful scheme	12
5	A traded tax – who can trade, who can't pay	17
6	Other issues	30
7	Conclusion	33

Annex A - BP Amoco Pilot Emissions Trading System (PETS)

Annex B - Generic Results of the trading 'game'

1. Overview

This paper explores the ways in which the UK might most effectively be able to meet its commitment to reduce environmental emissions under the Kyoto Protocol of 1997. Under Kyoto, the European Union is committed to reducing emissions of CO₂ to 8 per cent below 1990 levels by 2008-2012. The UK has accepted a legal target of 12.5 per cent, and has set a domestic target of 20 per cent by 2010.

The paper takes as its starting point that commitment and the report of Lord Marshall of November 1998. We agree with Marshall's conclusion that a trading scheme for emissions is in principle the most effective and efficient route to achieve the UK's aims, while recognising that there are many businesses for which such a proposition is at present likely not to be possible. It is for this reason that the Marshall report proposed that a tax would also be necessary.

We also recognise that there are many uncertainties surrounding the issue of emission control. While some information exists about the scale of greenhouse gas emissions, it is largely statistical and not firm specific. Furthermore, estimates of the ability of businesses to reduce emissions, the cost to them of doing so, and the effect on their business are generally lacking. The estimates that do exist are based on models – notoriously fallible – rather than any direct experience.

The paper has therefore looked at ways in which a tax and trading scheme might be introduced which provides incentives to make reductions in emissions without producing too heavy a burden on business and one which allows individual businesses to make efficient decisions on their own account.

We argue that a scheme which allows producers to mitigate their tax burden whenever they reduce emissions to target levels and which *in addition* allows them to gain a benefit in a marketplace by making further reductions would be the most efficient, effective and equitable scheme.

Such a scheme

- Minimises the need to recycle funds
- Provides effective incentives
- Rewards those who are able to reduce emission below target levels
- Compensates those who find this difficult – so long as there are those who go further

The paper includes a specific proposal for how this may be done, by establishing a tax on emissions above the target level, and allowing trading between those who go further and those who find this difficult. By establishing a straightforward mechanism for certification (which will itself be necessary for monitoring Kyoto Protocol performance), it will be possible to encourage reactions that both reduce emissions and allow trading. Such a scheme means that companies can make their own decisions about the costs and benefits to them of particular routes to emission reductions. The paper concentrates here on CO₂ reduction, but could be extended to other greenhouse gases in due course.

The scheme described here is put forward for debate and elaboration – we do not deal with all the matters of detail that will be necessary before it can be put into practice. Nevertheless, we believe that it provides a starting point for discussion which offers a way forward in a complex area.

The paper starts by looking at the background and purpose of the study, before going on to look at the Marshall report and at an example of a trading scheme that has been introduced by BP Amoco. This background informs the fourth section that outlines the principles that are desirable in any scheme and the criteria that should be met. Section 5 outlines how taxes and trading might be integrated and provides a specific example, while the remaining parts of the paper examine some of the surrounding issues.

The proposed scheme is summarised below.

Criteria for a successful scheme

- BP Amoco's success in designing an implementable internal scheme is encouraging, and leads us to believe that Lord Marshall is unduly pessimistic about the possibilities for trading. We believe that the difficulties associated with trading are no worse than those associated with a tax. Introducing the tax and trading scheme we suggest may achieve the best of both worlds.
- The best way to choose what is most suitable is to let firms themselves choose whether to pay a tax or to engage in trading. Who can trade, who can't pay.
- Such a scheme brings market forces to bear on the problem. These are generally agreed to be more efficient and effective than administrative fiat.

Outline of the Scheme

- The scheme would be introduced in a number of tranches. In this example, we take an initial objective of a 5 per cent reduction, and an illustrative tax rate.
- All businesses to be included in the scheme are required to certify their current emissions in tonnes and those for any past years that they select back to 1990. It is important that the baseline chosen for the scheme should reflect the Kyoto 1990 date. Firms that have already taken steps to reduce emissions should be credited for these actions.
- A tax rate is set on these emissions of £4000 per tonne on 5 per cent of those emissions
- If the business can certify that their emissions are already 5 per cent down on their chosen baseline, they pay no tax.
- If the business can (or plans to) reduce its emissions further, then it can sell the extra into the market
- If a business finds it difficult to make cuts, then it can buy permits, which will be attractive at any price below that of the tax rate

- Any business can simply choose to pay.
- Although international emissions reductions are important, it is crucial to get the domestic scheme right first. This will then give the UK greater leverage in negotiations. UK firms should also be given credit for non-UK reductions, as this enhances the UK's negotiating position, giving it early mover advantages, and an ability to influence the international scheme structure.
- However, some firms may not be able to certificate their 1990 emissions (particularly firms created since then!). We therefore propose a system of self-certification for appropriate years back to 1990.
- We suggest that in the first instance the tax and trading regime be applied to emissions above 95 per cent of the baseline, with an announcement that this will be reduced to 90 per cent after three years, and 80 per cent after a further 5 years.
- Detailed issues related to different firms having different abatement costs, and the benefits from trade, are considered in Section 5.5. This analysis demonstrates the theoretical and practical advantages of trading in permitting low-cost reductions and avoiding high-cost ones that reduce competitiveness.
- Where there are high administrative costs of trading or reduction (for example for small firms), then they may choose to continue paying the tax. We expect, however, that market mechanisms – intermediaries and changes in negotiations over, for example, buildings – will in due course reduce the number of firms who so opt.
- We believe that using the VAT base, and therefore limiting the tax and trading scheme to VAT-registered businesses, may prove to be the most effective administrative method.
- Plans to reduce emissions should also be self-certified, and can be traded, thus permitting greater efficiency gains.
- A central agency would exist to underpin trading, perhaps purchasing at 50 per cent of the tax price. The role of this agency would decline as trading

became more established, and the market set its own prices.

- The scheme we propose forms a bridge between two apparently conflicting principles: the polluter pays principle, and the support of competitiveness.
- Section 5.6 illustrates the impact on industrial and service sector firms, and the benefit from the service sector firms reducing their emissions and trading with the industrial firm.

2. Background and Purpose

This paper is written against the background of the *Kyoto Protocol*, agreed on 11th December 1997 and the November 1998 report on *Economic Instruments and the Business Use of Energy* by Lord Marshall. Under the Kyoto agreements, the European Union is committed to reducing emissions of greenhouse gases to 8 per cent below 1990 levels by the period 2008 to 2012. As a share of the EU commitment, the UK has accepted – in June 1998 – a legal target of a 12.5 per cent reduction on 1990. This means finding an additional reduction of 5 million tonnes of carbon above that which is expected to be delivered by existing policies. The UK also has more exacting domestic target of a 20 per cent reduction in carbon dioxide (CO₂) by 2010. Such reductions will impose costs – they cannot be made freely. This paper addresses the question of how most effectively to ensure that emissions reductions are made at minimum costs.

All industrial and commercial processes, and indeed all of modern life, involve the use of energy in some form, which in turn almost always involves direct or indirect emissions of greenhouse gases. The most common emissions, and therefore those most important to control, are of carbon dioxide. Many key industries are *energy-intensive*, and many of these are subject to intense international competition. Altering the cost of energy to these industries can radically change relative competitiveness¹; particularly if the methods and severity of taxes or other instruments used in competitor countries is different.

It is therefore crucial that whatever instruments are used by the UK government (and by the EU) are *economically efficient*. This means that the method of achieving the targets set in Kyoto must be considered very carefully, and implemented equally carefully. Choosing the wrong methods will, at a minimum, lead to unnecessary distortions to the economy and, at worst, severely affect the UK's international competitiveness.

¹ The most recent exploration of competitiveness issues, which explored the effect of a \$100/ per tonnes carbon tax, was carried out by the Expert Group to the UNFCCC: "Competitiveness Issues related to carbon/energy taxation" Working Paper 14, 1997. This estimated that such a tax would add between 0.6 per cent and 11 per cent to costs in the countries and sectors in the analysis.

It is also crucial that the instruments used are *effective*, in that they deliver the reductions in emissions levels that they are intended to achieve. It is pointless (and embarrassing) to impose controls or cost penalties and then fail to achieve the objective set by international agreement. Removal of as many uncertainties as possible from the emissions reduction process is also crucial.

This paper explores how a system might be devised which provides effective incentives to reduce emissions where it is most cost-effective to do so, without burdening the taxpayer or requiring infeasible amounts of information. We take as a starting point the recommendations of Lord Marshall, and draw on BP Amoco's experience with an experimental emissions trading scheme in proposing a way forward.

These are summarised in the next section.

3. Lord Marshall and BP Amoco's scheme

3.1 Lord Marshall's recommendations

Lord Marshall lists the main methods that can be used to achieve the emissions targets:

- Regulation;
- Voluntary agreements;
- Negotiated agreements; and
- Economic Instruments, including both emissions trading and taxes.

He notes that emissions trading is already a reality, citing the successful sulphur trading scheme in the US, and that international trading will be a reality by 2008, and that emissions trading will inevitably form part of the solution. His summary of the advantages of a trading scheme is helpful:

Trading schemes give firms legal targets to reduce emissions. But they allow companies that can reduce emissions more easily to go further, and to sell the excess to companies finding it more difficult or expensive to meet their targets. In this way emissions reductions take place where it is cheapest, allowing targets overall to be reached more cost-effectively. This attractive flexibility for individual firms is combined with certainty for the regulator. With a fixed number of permits in circulation, provided that the compliance regime is robust, the regulator knows in advance what overall minimum reduction in emissions will result.²

However, despite recognising these clear theoretical advantages, Marshall is sceptical about the speed at which an emissions trading system can be introduced, and about how wide its coverage can be. He notes that small and medium sized enterprises (SME's), and less intensive users, together account for some 60 per cent of total carbon dioxide emissions³, and he does not believe that these firms will ever be involved in serious emissions trading. Hence he recommends that a tax be introduced as part of the solution, but with the provisos that:

² "Economic Instruments and the business use of energy", A Report by Lord Marshall, November 1998, para 44, p11.

³ *Ibid*, summary, p2.

- All revenues are recycled to business, perhaps through 'carbon trust' type schemes to promote low carbon technologies and/or energy audits/advice for SME's;
- The overall impact on the heaviest users should be reduced through a system of rebates; and
- The leading option for a tax is, in his view, a 'downstream' tax on use of energy.

Marshall is very concerned over a number of problems related to getting the right mix of instruments in his mixed approach, including:

- Whether countries or companies, or both, should be allowed to trade emissions internationally. (He believes it is essential to involve companies in the international process);
- Whether a domestic UK system could, or should, be introduced in parallel with the international one;
- Whether participants should be permitted to 'bank' permits, and the impact of this on ability to meet the Kyoto targets;
- Coverage, particularly in the world where only a limited number of companies would participate in a trading regime. (He is in favour of a regime which migrates gradually from those most able to implement it to others); and
- Methods of setting and allocating the initial permits.

These are all issues to which we return in this paper.

3.2 BP Amoco's Emissions Trading Scheme

BP Amoco's has introduced a Pilot Emission Trading System (PETS) with the aim of reducing greenhouse gas emissions within BP Amoco. This is described briefly in Annex A below along with the results of the trading 'game' in Annex B. It was launched on 14th September 1998, and to be run in the first instance for five years. It will focus on carbon dioxide emissions in the first instance, but is expected to be extended to other greenhouse gases in due course. All business units in the initial

system will have a verified baseline of emissions, an accepted method of emission estimation and cost curves for emission abatement options. Fines, at five times the peak price, will be levied on those who fail to balance emissions and permits. The scheme has a defined cap, and then permits allowances, allocated on the basis of past emissions (but incorporating reductions), to be traded.

There were a number of pre-requisites that needed to be satisfied before the BP Amoco scheme could be implemented⁴:

- In 1997, BP Amoco revised its internal protocol for reporting carbon dioxide emissions from all its operations worldwide;
- Defining responsibility for emissions where there were business partners (by equity stake); and
- How to treat indirect emissions, for example from the use of electricity (at present these are excluded from the scheme).

From 24th August 1998 to 9th September 1998, 12 Business Units (BU's) within BP Amoco participated in a trading game ("the Game") brokered by OTI. This is BP Amoco's Oil Trading arm - Oil Trading International, which was designed to simulate some of the situations and procedures that PETS may incorporate. Prior to this, the Game had been played with OTI's Derivative traders and marketers in London, Singapore, and Cleveland ("the Traders"). This has facilitated the identification of key areas of similarity and disparity in behaviours that can aid the development of BU trading practices. Annex B describes the results of this experiment. This highlighted some learning points, particularly about international/low information trades, and about what happens when price stability is breached. Crucially, it showed that a trading system could be introduced with players who are unfamiliar with the process and still reduce the costs of abatement within a very short time period.

⁴ These are described more fully in "An article on the purpose, design and implementation of British Petroleum Pilot Emissions Trading System", Jill Rutter, November 1998.

In a helpful paper, Jeff Morgheim sets out some of the issues related to creating such a scheme on an intra-company basis, highlighting the fact that this is more difficult than setting up schemes between companies.⁵

The issues raised by Marshall and the kind of system currently being implemented by BP Amoco suggest a number of principles that any tax or trading scheme ought to take as a starting point. These are laid out in the next section, before we begin to consider some of the more practical issues.

⁵ *“Emissions trading: economic analysis, capital budgets and performance contracts”, Jeff Morgheim, Commercial Analyst, Forties Pipeline System, BP Exploration, May 1998.*

4. The criteria for a successful scheme

We have looked for systems that combine both practicality and effectiveness. One over-riding criterion is after all that any scheme should have the effect of reducing the level of emissions. However, there are also some other criteria that need to be met. Any scheme should:

- Spread the burden of emissions reduction as fairly as possible
- Encourage those who can most easily/cheaply reduce emissions to do so
- Minimise information needs and costs of administration
- If revenues are raised, enable the recycling of funds to minimise the impact on competitiveness
- Be politically acceptable

We are essentially examining here how to regulate a new market. A product for which no market previously existed, i.e. emissions of greenhouse gases, is to be put in place internationally. Alternatively, we might see this as the invention of a new product altogether – the good of emission reduction. The ways in which such a product is made available are various and include the government simply deciding that we will all consume it whether we like it or not through general taxation.

Once, however, the problem is posed in this way, in our opinion it becomes clear that taxes on emissions and the ability to trade permits are simply different ways of applying a price to this particular product. It is therefore impossible to consider them separately.

Moreover, if we agree with Marshall that in principle a trading scheme is more efficient and effective than a tax system, then it becomes a key issue to consider how potential trading schemes interact with taxes in providing incentives and encouraging the introduction of trading.

In the light of BP Amoco's success both in designing an implementable internal scheme and in running a 'real-time' experiment to prove its effectiveness, we believe that Lord Marshall may be unduly pessimistic about the ability of the UK to

introduce emissions trading as an effective policy instrument for a majority of its emissions. It is clear, however, that not all companies will initially have the resources, or the will, to take the initiatives that BP Amoco has. We therefore endorse Marshall's views that the best method of introducing such a scheme is to encourage schemes to develop where companies have the resources, reporting and measurement techniques and internal desire to improve emissions. Such schemes could build up incrementally; starting with a small group whose emissions are already reported and which could cope with the administration, and gradually extending into other sectors over time. Providing incentives for companies to join trading schemes as quickly as possible and to limit their emissions wherever possible can effectively shorten the time scales.

The most obvious incentive is that trading will alleviate what would otherwise be a tax burden. Who can trade, who can't pay.

The central difficulty of introducing a tax can be described quite simply. Consider the imposition of a tax on the carbon content of energy production, which is levied on the suppliers of such energy. As a result they raise their prices and are encouraged, by some unknown amount, to supply alternative forms of energy. They put pressure on their suppliers to develop such sources. However, at this stage, we do not know to what extent any of this pressure will be successful or to what extent the new higher price of the energy product will result in a reduction in consumption. Thus setting the tax rate is a matter of guesstimate. The same problem applies if we tax the consumer. Leaving aside the political difficulties of this move, which have already been demonstrated by the failure of the plan to impose VAT on fuel consumption in the UK, there is no certainty of how large an effect on consumption and hence emissions any given tax rate might have. It is true that there have a number of studies building models of such effects⁶ but there are very considerable uncertainties involved.

⁶ *E.g., Equity and Ecotax Reform in the EU: Achieving a 10 per cent Reduction in CO2 Emissions Using Excise Duties, Terry Barker & Jonathan Kohler, Fiscal Studies, 1998 Vol 19*

A tax would be a possible and effective way of approaching the problem if we knew with some precision the elasticity of both the supply and demand for emissions of greenhouse gases. This implies not just how consumers react to different prices (and differences between different consumer groups), but also the different costs of reduction of such emissions in different firms and industries.

For normal products, it is precisely the marketplace that we rely on to provide us with this information. But since the carbon content of energy is not (yet) a product in its own right (let alone other greenhouse gases), there is no structure of property rights to tell us how a price might be set or developed. Moreover, these are global products where there are bound to be different patterns of demand.

The Kyoto Protocol suggests that something that was free is about to have a price tag put on some part of its production. Above a free limit (at present), production of this good (i.e. greenhouse gases) will require buying in the right to produce. Parallels exist with licensing except that there are agreed production levels that don't yet require such a license. Individuals to whom the licenses apply will have to decide what to do. They can buy the license, cut back to the agreed level, or cut back below the level and sell the extra free time/space. In the case of Kyoto, these individuals are countries. It is countries for whom a lack of emissions has become a product – a good – and it is countries which must now work out how to make this market work within their borders to effect the production target which they need to meet or pay for their ticket.

If we assume that the country concerned does not want to buy anything, it therefore needs to cut back to a level at or below its permitted emissions level. However, it doesn't know the best way to do this, because it lacks sufficient information about how different parts of its economy will respond to incentives. It therefore has a choice. Either it simply tells people and businesses what to do, or it tries to find other ways of collecting the information it needs indirectly. This is what markets do. One of the justifications of market efficiency is that the process of trading allows participants to indicate their willingness to buy and sell at particular prices and thus the value they place on the product concerned. Instead of a planner needing to

know in advance all this information, a trading process enables the best solution to be found in real time.

So the key problem for the country is how to set up this market and ensure that people start using it. Once such a market exists, then many of the principles for success outlined in our criteria will be met. The burden will be widely spread, while there will also be an incentive for people to reduce emissions where they can most efficiently do so. Equally, information needs will be minimised. Trading obviates the need for tax collection and hence recycling of revenues. In our opinion, the best way to achieve these aims is to introduce a tradable tax on the domestic consumption of greenhouse gases – initially limited to CO₂. The remainder of this paper is devoted to outlining this idea and some of the practical issues in its introduction.

4.1 An Outline

The essential idea is to enable people to reduce their tax liability either by certifying their reductions in emissions or by buying permits from those who are able to reduce emissions below the desired limit. In brief terms it would work as follows:

- All businesses to be included in the scheme are required to certify their current emissions in tonnes and those for any past years that they select back to 1990.
- A tax rate is set on these emissions of £4000 per tonne on 5 per cent of those emissions
- If the business can certify that their emissions are already 5 per cent down on their chosen baseline, they pay no tax.
- If the business can (or plans to) reduce its emissions further, then it can sell the extra into the market
- If a business finds it difficult to make cuts, then it can buy permits, which will be attractive at any price below that of the tax rate
- Any business can simply choose to pay

The existence of the tax means that everyone in the scheme must make a contribution – but those who can contribute most towards a reduction of emissions can remit their taxes by selling their excess to others, if they reduce to the tax cut in level their tax burden will fall to zero, but if they choose to go on producing, they must pay. This enhances political acceptability around the polluter pays principle but also allows the recycling of funds on an automatic basis through the market. How an individual company chooses to do this is their own affair. This minimises information requirements. A large and an international company may choose to implement internal arrangements. But Kyoto is an arrangement between nations. If an individual company's own arrangements contribute to the country's international obligations, it will have to be accounted for within the country's 'books' for this particular product. The ability to sell the tax liability on encourages those who can reduce their emissions to do so and indeed to go further if it is cost effective to do so.

Thus the ability to trade the tax meets all the criteria set out at the beginning of this section. We have laid out the basic principles on which such a tax might work. The trick is to impose a tax that offers the right degree of flexibility and can be tweaked in the marketplace. It is to these practical issues that we now turn.

5. A Traded Tax – who can trades, who can't pays.

5.1 Marshall's tax

In order to examine in more detail how such a system might operate, we start by looking at some of the issues that have been raised surrounding a possible tax. The Marshall report suggests that the tax should be downstream and specific:

Paras 109-111: A 'downstream' tax could be collected from the suppliers of energy products to final industrial and commercial users. It would be paid for by the final users, and it may be sensible to include an explicit reference to the tax on energy bills to increase its visibility. Preliminary estimates suggest that the distribution sector for all energy products involves no more than about 3,000 businesses. The vast majority of these will already be registered for VAT. This would facilitate the administration of the tax since the distinction between supplies to business and domestic customers is already made for VAT purposes.

A 'downstream' tax would also:

- *ensure consistent treatment between imported and domestically produced fuels;*
- *help maximise its visibility to final users of energy, thereby increasing the likelihood of it having a significant impact on energy demand and emissions. It is also the approach advocated in the draft EU Energy Products Directive and that adopted by a number of other EU countries.*

The main drawback of a 'downstream tax' is that, since input fuels to the generation of electricity would not be taxed, a 'downstream' tax would tend to have less effect on fuel switching in the electricity generating sector than an 'upstream' tax.

However, it is considered that the electricity market can be dealt with separately.

Marshall considers other issues such as whether the tax should be specific or ad valorem⁷ (choosing specific), whether on carbon or energy (choosing carbon), the rate that should be set for electricity (reflecting carbon production), how to treat fuels which are inputs to the production of other fuels (no tax) and non-energy use of fuel products (again, not taxed). He also discusses renewables and methods of

⁷ *large literature from tobacco*

incentivising firms to use them, nuclear power (which he concludes is too difficult to exclude) and Combined Heat and Power (CHP) schemes.

Marshall seeks methods both of recycling the revenues in order to achieve environmental goals and reductions for the most intensive users. He does this because of his belief that, at least in the short term, trading mechanisms will not be able to bear the main brunt of reducing emissions.

However, it seems to us that his proposals for taxes followed by recycling and reductions lead to an inevitably complex system and numerous unanswered questions. It is not obvious that such a system will in fact have the desired ends, nor that it will be equitable, still less efficient.

5.2 Parallel Systems

Our consideration so far leads to the conclusion that emissions trading is not only theoretically desirable, as the Marshall report also agrees, but may also be no less practicable in delivering the right levels of emissions reductions and placing the burden where it can most readily be borne.

The fact that companies such as BP Amoco have taken the trouble to develop a scheme, and have, at least in part, demonstrated its feasibility and effect, should be taken into account in defining the mix between tax and trading. We need to create a system that permits the co-existence of a tax and the introduction of trading from the outset. We recognise that a tax element is required to capture those who will neither want to nor be able to trade. But the greatest encouragement should be given to trading.

Before looking in more detail at how to do this, we first examine two issues which need to be addressed in both cases. These are the interaction between international and domestic issues and the baseline question.

5.3 International versus Domestic Issues

The starting point for any form of organisation of the control of global greenhouse gas emissions is the Kyoto Protocol. While there are many ways of looking at the need for controls, or the climate consequences of different levels of controls, the current organisational parameters for the global system are set in the targets negotiated in that agreement. This agreement set the targets for global and national emission levels. Within this, therefore the UK has its own target (and more demanding criteria of its own choice). The reaching of any particular target may be a global issue but it is clearly mandated and moderated through national institutions.

It is therefore for these national (or in some cases federal) institutions to decide how their individual targets may be reached. To this extent, any tax or trading scheme will be set by the relevant authorities, with the aim of meeting these targets. The relevant authority will only be concerned with its domestic emissions, except to the extent that it can trade off its own emissions against international reductions. The existence of multinational firms will be relevant to them in this context – that such firms, headquartered in the home country, may themselves be able to facilitate such transfers through their own internal operation. Indeed, this can be a very important aspect of the national scope for flexibility. Otherwise, the international operation will only be of indirect interest, in the sense of maintaining successful firms within the economy.

From a domestic perspective, it is of no direct use that an international company has reduced emissions in China rather than the UK. However, if the domestic authorities know this, then it becomes an element in the negotiating of international trade-offs. Indeed, it may well be to the national authority's advantage that international companies can make contributions in this way.

These considerations suggest that the domestic situation is likely to be at the centre of attention. If this can be got right, and this means meeting the mandated emission reduction at minimum cost, then international trade-offs can move that cost function downward by effectively offering a cost trade-off, or move the emission reduction constraint outward. In principle, these two movements can be equivalent.

Therefore, the more effective the domestic scheme is, the greater advantage it offers to the national authority and the international firm in capturing first mover advantages.

If we concentrate on establishing the most effective route to domestic reductions, this is likely also to lead to the ability to make the most effective international trade-offs. It has been suggested that moving to a system that is unlike any system that the climate change negotiators finally come up with will be a disadvantage. This seems wrong on several counts. Firstly, the negotiators themselves will be looking for patterns and examples. Early movers will benefit here. Second, any schemes which reduce the costs to the UK of emission reduction, of whatever form, will increase the latitude that we have in later years in any form of negotiation, whether on trading schemes, targets or whatever.

Thus, the central issue remains to discover what the most cost-effective route actually is and how taxes and trading might most effectively be combined or used to achieve emission reduction. We have suggested above that the simplest way to think about this issue is in the context of new products. We have created a new product, which did not exist before. This good is labelled emission reduction and it comes with all kinds of health benefits, which its proponents have been pushing for long before the product actually came to market.

The problem then clearly becomes two fold. One is that there is no market on which emission reduction can be bought and sold. The other is that actually, we want someone else to buy it for us. This is perfectly sensible. Emission reduction is not a good we can individually consume. Hence the difficulty in setting targets in the first place and the large role for international negotiations. This suggests that it will be hard to set up a market in which we can set a price for emission reduction. However, a market for the 'bad' of emissions themselves may be much easier.

5.4 Baselines

This new market can only come into existence when the good and its associated bad have been defined. This means that the baseline for its calculation ought to be when that set in association with the targets. In the case of carbon, this is 1990, though some of the other greenhouse gases have different dates. Prior to this, there is no basis on which to set targets against which progress can be measured. Equally, efforts which have been made by individual organisations to move towards these targets on a global basis (for example by some multinationals) can then be counted towards those targets and such organisations would not be penalised for being early movers. It is in our view important to set a baseline date that would not in principle penalise early movers, since such operators are precisely those that have taken the problem seriously. It is because of this that we recommend that the UK should take as its baseline date that set for the Kyoto targets.

Doing this means that the bad (and good) only start to exist above the target level. Below this level, the production is essentially still free, at least at the moment. The alternative to this is to avoid the baseline issue by creating the market in all amounts of production of the bad. However, this would be inconsistent with the spirit of the arrangements reached so far.

In practice, there are some problems in creating a liability based on a 1990 estimate, once individual companies want to certificate their own performance. To overcome practical difficulties of businesses that either did not exist in 1990 or do not know what their emissions were, we believe that they can certificate themselves against more recent years (up to the previous tax year) if desired. Thus early movers can reap the benefit of changes already made, while those who have not made this effort will have to make more rapid reductions.

We also believe that it is emissions that should provide the basis for the tax and trading scheme. This means at the outset the government must calculate and publish its basis for deciding the carbon content of each carbon producing purchase. In any case, this will be an important element in *any* possible scheme for reducing emissions. It will also need to consider the carbon content of different types of fuel use for

certification purposes. If an individual business is certified by its accountants that its electricity bill has fallen by a certain amount, a rule must exist for translating this into a carbon reduction.

These rules will obviously be capable of continuous refinement and development over time and are likely to become part of the regular process of tax setting. Once any information becomes the basis of charges, it will now doubt be to everyone's advantage to clarify its basis. The current scheme proposes a mechanism where a start can be made on the basis of minimal data and there is an incentive for businesses to provide their own baselines.

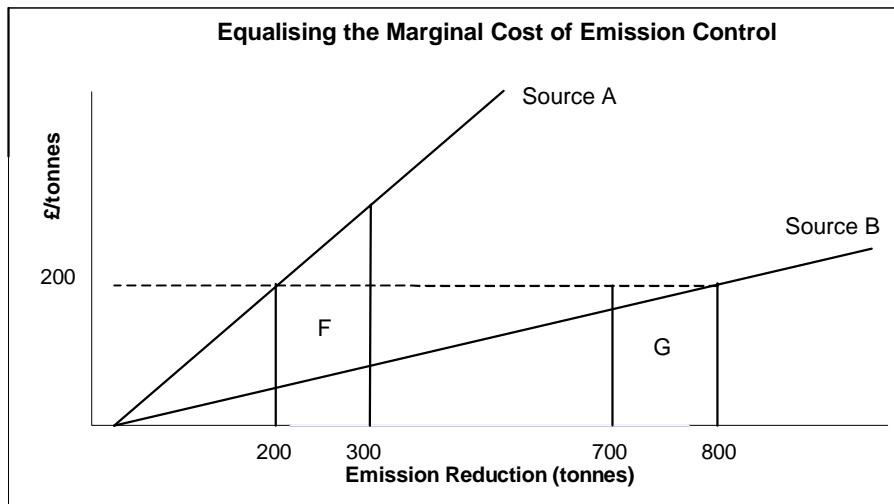
Progress will also need to be made gradually towards the full Kyoto (or more demanding) limits. In the first instance, for example, the tax might be applied only to emissions above 95 per cent of the baseline. To concentrate minds, it could be announced that the tax would apply to those above 90 per cent after three years and 80 per cent after a further five years.

5.5 The System

The administrative problem is how to set a price such that the best incentive is reached to produce the good of emission reduction. In a world of perfect information tax or a market could do this interchangeably. The tax on production would raise the price of such production and producers would reduce their output where the cost of doing so was less than the imposition of the tax. If the reaction functions of all producers were known, then the tax could be set at an appropriate level to achieve this.

There would then be differential rates of tax to reflect the different cost structures faced by different producers, with a higher tax rate for those whose cost of reduction was lower. In this way the burden of the tax would be proportionate to each producer. In effect, this means tailoring the tax rate to the slopes of the abatement curves. Such a possibility is shown in Figure 1. The different slopes of the curves for A and B illustrate the different costs of emission reduction in the two cases. A

much bigger difference in charge would be necessary to reduce emissions by 100 tonnes in the two cases.



In practice, knowing the precise slopes of these curves this is impossible and in any case, differential rates of tax would be expensive to administer. Moreover, there would be huge costs of compliance and setting of information standards.

It is this difficulty which trading schemes avoid. By creating a market in the permits to produce the bad, they allow the price mechanism to provide the information to producers which makes it possible for them to discover the most cost effective mechanisms for abatement. This is much less information intensive than the administrative route of having to provide sufficient information to allow the authorities to calculate the efficient tax rates. It is therefore not the case that trading is less information intensive. It is certainly more intensive than the crude tax rate, but then this also achieves a less efficient outcome. Indeed it is possible that it will fail to achieve anything like the desired outcome, with huge costs for some while others fail to make the reductions that they could achieve.

We suggest therefore that a system be established where businesses may choose either to simply pay the tax or to trade. Companies such as BP Amoco which take the trouble to introduce schemes would then be encouraged to continue with them. Other companies, including SME's, who do not have the inclination or resources to participate in trading, would simply pay the tax, but would still be able to start using

the trading system when they were able. At the outset, we might wish to exempt smaller businesses but in the medium term they could be included. Because the long term objective is to utilise trading as much as possible, the pricing should allow from the outset that companies that reduce their emissions would pay no tax.

Marshall indicates that the distributors of emission producing product number about 3000 firms. He suggests that it on this community that a tax should be imposed. We are not convinced that this is the correct baseline. We would rather suggest that from the outset the tax liability should be applied to all businesses above a certain size (for example £1million turnover) and subsequently extended to the whole of the VAT base.

An individual business with relatively little energy use might decide simply to pay the tax and reduce profit. Or it might be operating in such a market that it could pass on the tax to consumers with no loss of sales. In these cases of course no reduction in emissions takes place. To reduce emissions we need to encourage even these firms to look at the potential for emission reduction. For example, in the case of the occupiers of an office building, there are ways of reducing energy use by improved management systems, new techniques and indeed new technology. Normally, such systems are the responsibility of the owner of the building, and the tax system would create an incentive for occupiers to negotiate with owners. If the implementation of such schemes will save tax, then these are more likely to be introduced. It will be up to the individual business to prove that the reduction has been made and some standard ways of doing this will need to be introduced. In any case monitoring of progress towards the Kyoto targets will also require considerable monitoring. It is perfectly possible to imagine that the annual audit can easily include a certification of therms used from fuel bills with very little additional effort on the part of auditors.

Using the VAT base also suggests a relatively straightforward mechanism for checking company certification of returns, since these can be made at the same time as a VAT audit is made. The additional information that the VAT Inspector would need is the rules on carbon content of purchase items such as electricity etc. One reason for an initial limitation on the number of companies to be covered is to allow

such a system to get up and running, without encouraging too much self-certification of an imaginative – or worse – basis.

Many businesses will end up paying some tax. However, there is an additional potential way to mitigate loss that can be designed and which also allows for recycling of revenues or potential revenues.

The tax liability has been set at the outset. The tax rate selected here for expositional purposes is £4000 per tonne. This charge, multiplied by 5 per cent of the UK's CO₂ estimated emissions, represents about 1 per cent of the UK's gross valued added. This rate has been used for expositional purposes as a feasible rate, which is none the less significant for an individual business. A business with £2million turnover, faced with an additional £2000 tax bill would, in our opinion, neither panic nor be complacent. Such a bill both would focus on the need to avoid the payment and indeed on possible means of taking advantage of emission reduction schemes.

It may be that a particular business has already reduced its emissions by internal means and will meet or exceed the tax threshold. It may also be that it plans to do so. In this case, it can put any part of its plan to reduce below the permitted threshold back into the market, selling either bilaterally or through a broker and either on the spot or the forward market. The scheme therefore gives two kinds of incentive to meet the target. The first is that doing so will reduce taxes, the second is that there is a positive benefit in going further. The broker is supported by the government to buy in offered production at initially some fixed price, say 50 per cent of the tax rate. These taxable amounts can then be bought by producers who find it difficult to reduce their production, or who will need to invest heavily to do so. Any portion of production can be put into the market and the broker can set a margin between purchases and sales to pay for the market administration. Once the foregone emission rights have been bought, then the corresponding tax liability of the purchaser is reduced. The producer would only need to pay the full rate of tax on those emissions for which it was unable to buy others' liabilities. Equally the seller of permit would receive revenue from reducing its emissions below that average (taxable) level.

It is of course the case that reporting would be required, but initially only of those firms that were covered by the tax. Businesses can simply pay the tax and produce their annual certificate of emissions if they feel that the impact is not severe enough to be worth mitigating. Over time, it is likely that nearly all businesses will see some advantage in mitigation, and the certification requirement will also make possible the monitoring which is necessary for Kyoto purposes.

At the outset, it will be difficult to determine a price for purchase. It seems likely that it will need to be set at a relatively low level in relation to the tax rate to encourage the market to develop. This might be 50 per cent of the tax rate price, for example. As the market develops and further, non-taxed, production may be offered, the market will develop its own pricing, relative to, for example, the cost of emission reduction and alternative production methods.

If trading were to develop fully, the scheme would also fully replace a tax, such that no revenues were actually being paid to government and thus requiring recycling methods. If no other forms of recycling were available, this would also encourage firms to participate in trading. Moreover, the scheme could form a bridge between two otherwise conflicting positions. These are:

- The polluter pays principle. Environmentalists (and many others) argue that since the pollution is a bad, it is not up to the sufferers from pollution to pay the polluter to stop but rather the polluter should pay for the damage being done.
- The support of competitiveness. Many of the businesses affected by possible taxes trade internationally in highly competitive markets. They are extremely vulnerable to additional burdens of the kind that a polluter pays principle might involve.

A tax where recycling was possible through trading and the effective tax rate was therefore being set in the marketplace would ensure that the polluter pays principle was maintained, while allowing individual businesses to mitigate their own liabilities, according to how valuable to them the additional production actually was.

Thus the aim of such a scheme is to:

- Encourage trading in order that emissions targets can most easily be met
- Facilitate recycling of revenues

It is the contention of this paper that trading is not as difficult to introduce as some of its critics imply. In particular, while its information requirements are indeed onerous, they should properly be compared to those needed to design an effective tax, not those required to design a more simple one, which is not only blunt on the relative cost of emission reduction by different firms and sectors, but also possibly even on the issue of emission reduction versus energy use. In any case, in time emissions will have to be reported anyway - the UK has to know its emissions in order to know whether it has met its commitment.

What is required is a mechanism that would provide some baseline parameters for the introduction of trading – which in our view are also required for the effective introduction of a tax. This can then provide the starting point for a market to allow the exchange of such tax liabilities in a market place, allowing a redistribution of the gains and losses on the basis of individual requirements.

Such a scheme would obviously be oriented to the UK's requirements and obligations and would reflect only the UK's production of (strictly only CO₂) greenhouse gases. The contribution that individual multinationals could make to such reduction – and the contribution that UK companies could make to international trade-offs would be relevant to setting baseline targets but would be outside the scope of this particular scheme.

5.6 Illustrations

The detailed effect of these provisions on individual firms is imprecise at present, as we know very little about how individual businesses might potentially calculate their own abatement processes and therefore the prices at which below target reductions might be offered for sale. However, it is worth illustrating the overall possible outcomes.

The table below shows some illustrative tax burdens by sector at two different tax rates *if there is no success in reducing emissions*. It shows the scale of incentive that there would exist to reduce emissions, since every 1 per cent towards the target would reduce the tax bill by 20 per cent. As well as illustrating the overall charges, the table also looks at three of the most emissions intensive sectors, cement, basic chemicals and basic iron and steel. The table also uses gross value added as an illustration, since this enables a comparison with the tables in the Marshall report. However, there are a variety of different ways of computing the tax burden. Since the VAT base seems the most appropriate mechanism for levying the tax, this is also relevant to the comparison.

	GVA* (£m)	CO₂* (000t)	5% (000t)	Tax rate @ £2,000		Tax rate @ £4,000	
				per tonne Tax (£m)	Burden (%GVA)	per tonne Tax (£m)	Burden (%GVA)
Industry	468,416	36,989	1,849	3,699	0.79	7,398	1.56
Services	718,672	21,873	1,094	2,187	0.30	4,375	0.61
Total	1,187,088	58,862	2,943	5,886	0.50	11,772	0.99
Cement	955	1,155	58	116	12.09	231	24.19
Chemicals	15,283	4,595	2230	460	3.01	919	6.01
Basic iron	10,135	7,748	387	775	7.64	1,550	15.29

* Source: Annex 2 Marshall Report

The following table illustrates various potential outcomes for a representative industrial and service sector firm with £10million gross value added. Since the industrial firm has a larger carbon use, its tax bill at £4000 per ton on 95 per cent target is larger, indeed more than double that of the service sector firm. However in both cases if they reduce their emissions by 95 per cent, nothing at all is paid. In either case, they could reduce their emissions below this level. If they succeed in doing this by another 5 per cent, and sold the resultant reduction to a firm which was finding it difficult, then in this example, with the trading price at half the tax rate, there would be a revenue of 50 per cent of the maximum tax take. Equally, if they were able to buy permits at this price, then the cost of the emissions would only be half the tax rate.

TABLE 5.2 - IMPACT ON REPRESENTATIVE FIRMS – 95% TARGET £000S					
Firm	Gross Value Added £10m	pays tax @ £4000t	reduces to target	reduces to* 5% below	buys permit
Industry		-157.9	0	78.9	-78.9
Services		-60.8	0	30.4	-30.4

** trading price at 50% of tax rate for illustration*

Clearly, since service sector firms have lower emissions, it would require more than two such firms to be able to reduce their emissions by an additional 5 per cent, for there to be sufficient trading for the industrial firm to buy sufficient to be able to entirely replace the tax burden. Even some contribution, however, would help.

6. Other Issues

It is recognised that the implementation of such a scheme would benefit from a wider tax base than recommended by the Marshall report. We believe that if incentives are going to work even under a tax only scheme that the tax base chosen is too limited. More businesses will need to see that there are consequences of emission reductions if these are to be achieved. In addition, the greater the spread of the effect, the lower the burden that needs to be carried by large international firms that tend to be more exposed to international competition.

It may be argued that a wider tax base is impractical. However, it turned out to be possible to implement the introduction of VAT in spite of similar objections. In the case of greenhouse gases, the moral imperative is far stronger. The existence of the VAT system and accounting that is already in place also provides a framework for both the tax and its remission. While there are clearly costs in this route, it may turn out to be less costly per effective unit of reduction of emission than a narrower base.

6.1 The Market

The existence of a market can also not be taken for granted. At the outset, there may be fixed costs in establishing the marketplace, educating traders and encouraging the sale of permits. As the market develops, however, it may well become profitable, especially as firms realise that they can pay for further reductions in their emission levels. The fixed costs are a general benefit to the UK in helping it to meet its commitments and should be supported out of general taxation. It is also possible of course that the market simply runs out of supply. If everyone can reduce their emissions to target or below, there will be no purchasers at the domestic level. In this case, however, the government itself will probably be an international trader selling in the international scheme, in whatever form it takes, the excess permits provided to it by the market, or indeed bilaterally by international firms.

6.2 IPPC

Finally, there is the issue of interaction with other schemes, notably IPPC. This directive already requires a subset of businesses to be using best environmental practice and takes a regulatory and interventionist approach to defining this, admittedly on a fairly limited agenda. In our opinion, the government should be using the introduction of a certification procedure to limit what are likely to be some potentially wayward impacts of this directive. If individual businesses can show certificated energy use reduction, the impact of the regulatory procedure should also be abated and the government should be arguing for this.

Other forms of integration into the overall system are possible. The IPPC certification process relies on an environmental regulator agreeing that the site is using best available techniques (BAT). There is no reason why the existence of a certificated target reduction should not be taken as evidence of such a process without the need for additional costly and time-consuming detail. Equally, if the site in question were able to offer to sell emission production to the broker, this would constitute still further evidence that such a site or company was complying with the desired targets. Only if the installation were unable to provide a certificate showing it had reached target reductions would it need to show that techniques for doing so were unavailable or too expensive (along the lines indicated in the Directive).

6.3 Timing

This paper has suggested that the initial target is a 5 per cent reduction, followed by further extensions over following years. For some individual businesses, this may be onerous, even with trading. For example, the most carbon intensive sector appears to be, from Annex C of the Marshall report, the cement, lime and plaster industry. The tax rate suggested above, while only representing 1 per cent of gross value added for the UK as a whole, represents about 25 per cent of that sector's GVA. This perhaps suggests that a more detailed working of the figures would imply a lower tax rate at the outset for the more limited group of businesses that we envisage being covered. Alternatively, the first imposition of the tax might be taken over a rather longer period than a year.

6.4 Other Greenhouse Gases

We have concentrated here on the production of CO₂. This is partly because it is the most important, partly because it is also that which the Marshall report concentrates on and partly because most information is available for it. However, the scheme proposed above could be extended to other greenhouse gases fairly readily as better information became available which would enable baseline calculations to be made. The most obvious target for consideration would be methane, as it is an extremely potent contributor to the greenhouse effect, even though emissions are at a lower level.

7. Conclusion

This paper has argued that there is a way forward on mechanisms to reduce emissions that will provide a sensible and workable set of incentives for businesses – and eventually households too.

Such a scheme still clearly requires further work to establish the details. We believe however that it is feasible to:

- Establish a tax regime to cover all VAT businesses in due course
- Allow such businesses to sell permits that are related to their likely carbon usage
- Establish a certification scheme
- Develop a market in permits supported by government and its own international activity

Such a scheme has a number of advantages in producing a market. It does not require the government somehow to find the correct tax rate in advance but rather allows differential tax rates to emerge in the market. It does not require the establishment of complex recycling regimes. By providing a mechanism by which firms certificate themselves and understand energy use better it also encourages the reduction in emissions across a wide spread of activities.

In our opinion, this approach offers a fresh way forward on the important issue of emission reduction and the abatement of its consequences.

Annex A: BP Amoco Pilot Emissions Trading System (PETS)

This note clarifies the framework for the BP Amoco Pilot Emissions Trading System (PETS), building on the work which has been done to date within BP Amoco and in association with the Environmental Defence Fund (EDF).

The system is intended to provide:

- A cost-effective mechanism for the reduction of greenhouse gas emissions within BP Amoco.
- A clear signal of the seriousness of BP Amoco's commitment to tackle climate change and our emissions profile.
- An educative process for BP Amoco in the operation of an emissions trading system.
- A source of competitive advantage for BP Amoco in being able to influence the design of future national and international systems.

The approach is incremental in nature with an initial group of participant Business Units testing the system before widening out to include additional BU's and perhaps to bring in other companies or external plants.

Description of Trading System

The system involves two key elements:

- caps on emissions;
- a mechanism to allow trading.

1. Coverage

The intention has been to keep the pilot trading system as simple and transparent as possible. The system will centre on CO₂ emissions. Parallel systems covering other Greenhouse Gases (GHG) like CH₄ may emerge as experience develops. As the global warming potentials (GWP) are well known for the various greenhouse gases, it may be possible to effectively unite any two such systems with an appropriate exchange trade.

2. Unit of trade

The BUs in the pilot group, have 1997 emission levels ranging from 4 Mte to 0.2Mte. The **CO₂ emission permits** will be **set at 100 tonnes per annum of CO₂**: pricing will be in dollars. OTI will hold permits equivalent to 10 per cent of the targeted annual emission reduction which will be used to add liquidity to the market and help prevent market 'squeezes'.

3. Entry requirements

The initial group of BUs have a known history of CO₂ emissions dating back to 1995. Requirements for entry to the system will be the same for any new starters as for the original participants:

- verified baseline of emissions
- accepted method of emission estimation
- cost curves for emission abatement options.

4. Compliance periods

Group HSE has allocated annual allowances, for a five-year period in the first instance. Each participant has been awarded a series of annual emission permits. The one year duration fits the balance between being sufficiently short to promote trading activity, and sufficiently long to be operationally logical.

The obligation on each BU is to keep emissions in line with the allowance for the relevant year. At the end of the year, there will be a 60-day grace period in which participants will be able to balance their accounts. Excess permits can be sold back to the Broker.

The Kyoto protocol allows emissions permits not used in one period to be carried forward to the next. This form of banking is allowed within PETS and participants are also able to buy permits for future years at any time. However, borrowing of forward or future permits is not allowed.

Throughout the year, BUs will be able to trade permits with other participants in the system through the central broker, buying up or selling out permits to cover their projected emissions. While it will be possible for BUs to exchange relevant information and agree a deal bilaterally, all deals should be completed via the broker.

5. Compliance

The requirement to comply is what makes the permits valuable. We therefore need a credible compliance regime. Fines will be levied at the end of the year for BUs which fail to balance their emissions and permits. **Fines** will be five times **the peak price** for the year. Furthermore, the BU will have to purchase sufficient permits to balance their emissions.

6. Launch date

The trading system will be launched under the pilot from 14th September in respect of allocations for 1999, 2000, 2001, 2002, and 2003.

7. Allocation

The target for BP Amoco as a group has been set, and those for the participating BUs are consistent with that. The initial allocation method is based on future emission forecasts. However, as the trading system develops it will reallocate permits (and therefore emissions) in accordance with abatement costs. The permits will be distributed free.

8. Pricing

The initial price has been determined by examining the abatement costs put forward by the participating BUs. The initial price is **\$21 per tonne of CO₂ (\$2100 per permit)**.

9. OTI

OTI's role is to act as broker in order to facilitate trades and aid liquidity. It will maintain registry of credits and monitor all transactions. All trades will be tracked and bid/offer spreads made available to the BU's. OTI will also develop control and MI reports/documentation to assist BU's in their planning processes.

Additional Points

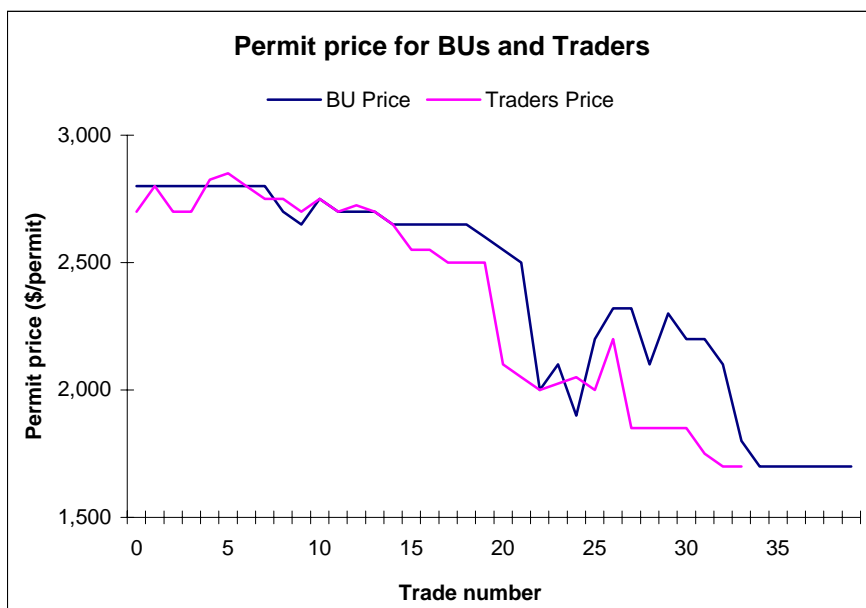
- Intranet will be used to maintain permit price information: the bid/offer spread, the last permit trade price, and the volume of permits traded to date.
- Primary focus of system is to reduce BP Amoco's total emissions - not make trading income
- Trading profits can be added as extraordinary item to result for the BU. Most accounting issues can be handled at a later stage since transactions are currently of an MI nature. This will change once credits have a cash value outside BP Amoco.
- There will be an ongoing coaching and training effort to ensure that the BUs understand both the rules and the possibilities of the system.

Annex B: Generic Results of the Trading 'Game'

Some of the high level results are tabulated below:

	Business Units	Derivs Traders
Total number of trades	40	34
Cumulative total of BU sales/purchases (excluding OTI)	59	45
per cent of trades that are bilateral between BUs (i.e. exclude OTI)	73.8%	66.2%
No. of permits traded	41,262	33,470
Total value of permits traded	\$95,017,790	\$76,073,025
Weighted average price/permit	\$2,303	\$2,273

It is encouraging to see that the BUs not only completed more trades than the Derivs Traders, but they also managed to 'match up' their deficits and surplus a higher proportion of the time (73.8 per cent). This meant that, on average, five BUs were involved in trades each day of the Game. [There were obviously occasions when one business unit was involved in more than one trade in a day, however, the counterparty to the trade was often different.] The BUs traded a greater volume of permits, although the average price of a permit was \$30/permit higher than that achieved by the Traders. The permit price profiles for both the BUs and the Traders is shown on the graph below.



It is clear to see that both times the Game was played the permit price was pushed downwards by around \$1000/permit (\$10/tonne). From the perspective of testing the theory that an emission trading system can deliver emission reductions at a lower cost, this is a promising result. This fall in permit prices could have occurred purely as a combination of the cumulative effect of the headlines that were sent out during the Game - some of which reduced abatement costs - and the capex that was available to be spent by the BUs. However, further analysis shows that this is not the whole story.

A simple weighted average of each BUs abatement costs and permit allocations at the start of the game shows that the cost of 100 tonnes of CO₂ reduction (1 permit) was \$3,064, yet trades took place on Day 1 of the Game at \$2800 (BUs) and \$2700 (Traders) in which both parties saved money. Furthermore, the average of the abatement costs that the BU faced during the last year of the Game (thus the abatement cost that they would face if they did not own a sufficient number of permits for that year) is \$2,595 for 100 tonnes of reductions. During this same period, permits traded, and indeed stabilised, in both iterations of the Game, at \$1,700/permit. This is nearly \$900/permit lower than may have been expected without a trading system.

Another way of looking at this data is to say that the use of a trading system to make emission reductions in the areas where costs are lowest has enabled the pilot group to meet its reduction targets at an average of \$9/tonne less than would have been possible without it. Since the Game required a group-wide reduction of 4,663,270 tonnes of CO₂ from business as usual levels, this represents a saving of around \$42m. However, since some of the larger trades were made at times when the savings were above \$9/tonne, the actual total pilot group saving for the BUs is closer to \$58m (\$47m for Traders). Some of these savings are due to capex effects, but even with capex discounted, savings are in excess of \$40m. Since most the figures used in the Game are arbitrary, it is worth noting that this represents a reduction in the pilot group's total reduction costs of 21 per cent (from \$193m to \$153m).

Specific Results and Learning Points

- Every BU took part in the Game and made trades that benefited both their own BU and the pilot group as a whole.
- Trade number 27 for the Traders was between two American BUs and was agreed bilaterally outside office hours in London. The OTI broker was then informed of the deal the following morning. Whilst there is nothing improper about this procedure, the price 'spike' that can be seen in the earlier graph, clearly shows that the BU that was selling the permits used its temporary monopoly position to force the price up to a level that was above the markets normal trading level. A more 'efficient' trade for the Group (and especially the BU buying the permits) could have been achieved if the broker had been allowed to look for other 'offers' in the market.
- On both occasions that the Game was played, the market traded around the level it was set at by OTI for several trades (Traders: 15 trades, BUs: 17 trades) before the \$2700/permit level was broken. This was probably due to a combination of two factors. Firstly, the BUs that spent capex to reduce abatement costs had to wait for two 'quarters' (days) for the money to take effect. However, since only two BUs actually spent capex, this effect was minimal. It therefore appears that the initial lack of direction for the price of permits was caused by uncertainty within the BUs about what direction the permit price would take and thus what strategy they should follow. Therefore it logically follows that pilot groups gains when PETS is launched can be maximised if the BUs have some ideas about the direction that the price profile will take and also of their role in the system at various price levels.
- Once the initial price stability was broken the Traders permit price profile dropped at a rate that was faster than that of the BUs. This was mainly due to the Traders adopting a more aggressive bid/offer procedure than the BUs. This was to be expected as these procedures are much more familiar to the Traders. However, a couple of key behavioural observations can be made. Before approaching the broker with a bid/offer price, it is always advisable to ask where the market is currently trading at - what bids and offers are already around. [It should be noted that this is something that will be easier to do

when PETS is launched as this information will be available on an Intranet site.] If this procedure is followed, it should help avoid the second point, which is that BUs should be careful not to make bids/offers that are 'through' the market i.e. a bid that is at a higher price than there are currently offers (and vice versa). This is something that did improve as the Game progressed and was certainly significantly better during the last 2 days of trading.

The information summarised above will be combined with some of the more BU specific developmental issues to help OTI produce a learning/training pack for each Unit. This should help ensure that the inherent advantages of the PETS can be fully maximised.