Economic instruments and the business use of energy

November 1998

A Report by Lord Marshall

FOREWORD

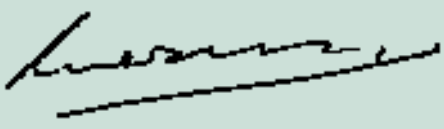
Chancellor of the Exchequer

In March 1998, you asked me to lead a Task Force on the subject of whether and, if so, how best to use new economic instruments to improve the industrial and commercial use of energy and help reduce emissions of greenhouse gases.

I am now enclosing my report. There was a wide measure of agreement among those we consulted that economic instruments did have a role to play in meeting the UK's climate change commitments, but little consensus on exactly how they should be used. This report offers my recommendations. It has been necessarily a brief survey. More work is undoubtedly needed in this complex area before the Government would be in a position to implement solutions on the ground. But I hope this report will help to move the debate forward.

I am grateful for the support provided by members of the Task Force: John Gieve, of HM Treasury; Alastair MacDonald, of the Department of Trade and Industry; Dinah Nichols, of the Department of the Environment, Transport and the Regions; and David Howard, of HM Customs and Excise. We were all grateful for the contribution to our meetings of Jenny Barker, of the Confederation of British Industry, and for the assistance of the Task Force Secretariat.

I should like to thank also all the many individuals and bodies who gave unstintingly of their time responding to our consultations, in particular to the Advisory Committee on Business and the Environment and the Green Alliance. I know from my own experience that the stream of consultation documents which business is asked to respond to never seems to slacken. The excellent responses to our paper helped enormously to guide and to inform my thinking on the issues. I hope particular respondents will feel this report fairly represents their views even where I may have taken a different tack.



Lord Marshall

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Lord Marshall's Report on Economic Instruments and the Business Use of Energy

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In March 1998, the Chancellor of the Exchequer asked me to lead a Task Force on the subject of whether and, if so, how best to use new economic instruments to improve the industrial and commercial use of energy and help reduce emissions of greenhouse gases.

This is a very complex area and a wide range of views has been expressed to me. This report offers my recommendations. Mine has been necessarily only a brief survey. More work would be needed before the Government could implement solutions on the ground. But I hope this report takes the debate forward.

SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

On the role of business and other sectors:

- It is clear to me that all sectors of the economy – business, domestic and transport – will need to play their part if we are to meet our legally binding target for reducing greenhouse gas emissions set under the Kyoto Protocol, and the UK's domestic goal of a 20 per cent cut in carbon dioxide emissions on 1990 levels by 2010.

- I am also keenly aware that the commitments agreed at Kyoto were only the beginning. Even more challenging requirements are expected to emerge from future international negotiations. This emphasises the need for Government to look beyond the current targets and timetable, and provide clear, long-term signals to reduce emissions.

On whether economic instruments have a role to play:

- In my view, a mixed approach will be necessary. Within that context, I believe that there is a role for economic instruments in helping improve business use of energy and reducing greenhouse gas emissions as part of a package of measures, alongside existing regulations, voluntary and negotiated agreements, and other measures, and appropriate action on the part of other sectors. However, any measures must be subject to careful design in order to protect the competitiveness of British industry and maximise their environmental benefit.

On the two leading options:

(a) A system of tradeable emissions permits

- The system of international greenhouse gas trading provided for in the Kyoto Protocol, which should be in place by 2008, will be part of the long-term solution to reducing emissions. I am very pleased that international trading will be available to the UK as part of the solution to achieving its commitments.

- Any trading scheme will require a robust system of monitoring and verification. A starting point for this may be the framework provided by the Integrated Pollution Prevention and Control (IPPC) Directive.

- Practical considerations lead me to the conclusion that it may not be sensible for Government to introduce a fully fledged, statutory scheme domestically in the UK at this stage.

- But I urge the Government to step up its consultations with interested parties to resolve the complex issues involved in designing a trading scheme. Strong business input into design will be essential. Such consultation should inform the UK's negotiating position for the international scheme as well as developing expertise domestically so that British firms are ready, and our financial institutions well positioned, to lead in these new markets.

- As a first step, I recommend that the Government seriously consider a dry-run pilot with interested players, as soon as possible, as a means of learning lessons for the participation of our industry in the international scheme.

(b) On tax

- Even when the international trading scheme is fully developed, it is unlikely that all businesses will be involved. Indeed, I doubt whether it will ever be practical for the majority of small and medium sized enterprises (SMEs) and less intensive users in industrial and commercial sectors to participate in the international trading scheme. Taken together, these firms account for around 60 per cent of total carbon dioxide emissions from business, and may offer scope for significant improvements in energy efficiency and reductions in emissions.

- Hence, my conclusion is that there probably is a role for a tax if businesses of all sizes and from all sectors are to contribute to improved energy efficiency and help meet the UK's emissions targets.

- In order to help businesses plan for future investment and maximise the environmental impact of a tax, a clear signal should be given of the long-term direction of policy, with changes in the rates of tax made in a gradual and predictable way.

- Any tax must be designed in a way that protects the competitive position of British industry. To this end, I recommend that:

  – the revenues are recycled in full to business, with at least some of the revenues channelled into schemes aimed directly at promoting energy efficiency and reducing greenhouse gas emissions – perhaps through 'carbon trust' type schemes to promote low carbon technologies, and/or energy audits/advice for SMEs;

  – consideration be given to the treatment of energy intensive industries, with the aim of reducing the overall impact on the heaviest users, whilst retaining some incentive for all users to save energy at the margin; a system of rebates, perhaps with the relief targeted at plant level, seems the leading option here;

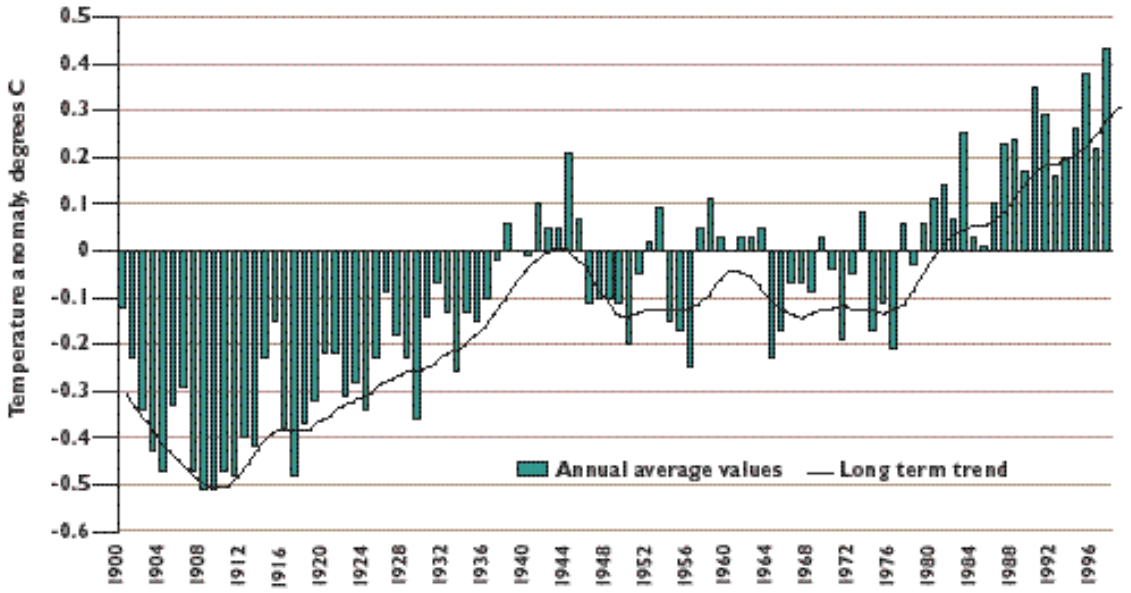
  – any measures are subject to detailed consultation about their design.

- Given current policy objectives for the domestic sector, the leading option for a tax would, in my view, appear to be a 'downstream' tax on the final use of energy by industrial/commercial consumers, with the tax rates reflecting (at least in broad terms) the carbon content of different fuels.
- The design of any tax should ensure that Combined Heat and Power (CHP) is not disadvantaged. It should also aim, where possible, to increase incentives for the take-up of renewable sources of energy.

INTRODUCTION

1. There is increasing evidence that climate change is happening, and the scientific consensus is that this is the result of human activity. Man-made emissions of so-called 'greenhouse' gases are altering the properties of the earth's atmosphere. The Inter-Governmental Panel on Climate Change predicts that if no action is taken soon to limit greenhouse gases, global average temperatures will rise by up to 3.5ºC by the end of the next century. Widely reported latest forecasts from the Hadley Centre[1] suggest that the impact could be at the upper end of this range. The effects of such a change in climate could be absolutely catastrophic across large parts of the world. This is a problem about which there is no little sense of urgency.

Figure 1: Global surface temperature anomalies[1] 1900–1997



[1]Compared to a 1961-1990 baseline.

2. At the historic Kyoto Conference in December 1997, developed countries agreed legally binding targets for reducing their emissions of six greenhouse gases[2] by 2008-2012. The European Union (EU) committed itself to a reduction of 8 per cent on 1990 levels.

3. As its share of this EU commitment, the United Kingdom took on in June 1998 a legal target of a 12.5 per cent reduction[3]. To meet it, the UK will have to find at least another 5 million tonnes of carbon[4] over and above the emissions reductions which will be delivered by existing policies. The UK also has its own domestic goal of a 20 per cent cut in carbon dioxide emissions on 1990 levels by 2010. That translates into a reduction of 29 million tonnes of carbon over what existing measures are expected to deliver by 2010.

4. Together these are very challenging aspirations which will require major changes to the way we live and do business. Carbon dioxide, the main greenhouse gas, is an inevitable product of the burning of fossil fuels (coal, oil, gas, petrol and diesel) to provide heat and power for our homes, industry and transportation. In the UK today, the energy derived from these fuels is integral to almost every aspect of our daily lives. Finding ways of reducing carbon dioxide emissions, therefore, presents a unique environmental challenge.

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[1] See Glossary

[2] Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.

[3] Other countries' targets are listed in Annex B.

[4] Throughout this paper all greenhouse gas emissions data will be converted to equivalent carbon dioxide emissions measured in million tonnes of carbon.

5. The Government currently expects to ratify the Kyoto Protocol in 2000-01. It has just initiated consultation on its broad approach towards achieving the UK's commitments. The consultation document *UK Climate Change Programme*, issued on 26 October, says that the Government will aim for a balanced and cost-effective programme involving all sectors of the economy. I welcome this, and am pleased to see a range of ideas in the paper for potential policy options on transport and on household energy use. Action by all sectors is essential. Industry cannot pick up the tab for everyone. Emissions data published by the Government shows that while greenhouse gas emissions from industry fell by 10 per cent between 1990 and 1996, the trend in the domestic sector has been fairly flat, while transport emissions are rising.

6. However, business must clearly play its part. Though emissions from industry and commerce have fallen back, they are still very significant polluters, with business energy use accounting for about 40 per cent of the UK's emissions of carbon dioxide. Business has a special role as the principal source in the economy of technological innovation.

7. In March 1998 the Chancellor asked me, with the help of a Task Force of senior civil servants, to consider whether economic instruments had a role to play in unlocking emissions reductions from industry and commerce. Our focus has been mainly on carbon dioxide as the subject of the Government's manifesto goal and the most prevalent greenhouse gas. This has led us to look at the industrial consumption of carbon emitting fossil fuels, but we have concentrated on fuels used as energy (lighting, heating, motive power and power for appliances): I have assumed that fuels used as petrochemical feedstocks would be outside the scope of any instrument, as they do not result in carbon emissions into the atmosphere in the same way as combustion does. Business transport was not included in the scope of our review.

8. My key concern has been to look at what mechanism would allow business to reduce carbon emissions and make its contribution to our targets most cost-effectively and with least damage to UK firms' competitiveness. That is why my working assumption has been that any revenues raised by an instrument would be recycled to business, so that though firms' incentives would change, its impact would be fiscally neutral.

9. At the same time I have been keenly aware that these targets are not the end of the story – that the commitments agreed at Kyoto are only the beginning if we are really going to tackle the threat of climate change. The implementation of the Protocol may slow the rate of change, but will not reverse it. Further, even more challenging requirements are expected to emerge from future international negotiations for the period beyond 2008. In looking at the options we have tried to keep in mind that whatever programme the Government designs will need to look beyond the current round of targets, and provide long-term, continuing, dynamic incentives to reduce emissions.

10. This is not least a competitiveness point in itself. The working life of capital investments can be very long in some industries. Without a signal soon of where we may need to be beyond 2010, there is a risk that firms investing now may get locked into capital stock which does not meet the requirements of the future. If one advocates doing the bare minimum now one must take into account the possibility that change could be more costly and painful as a result than if one had acted with the grain of the investment cycle.

11. I and Task Force members have consulted as widely as we could with interested parties in the time available. We are grateful to all those who responded to a consultation paper which we issued in June. (A summary of responses can be found at Annex A.) Many of the business respondents were large companies, but we have also tried to keep in mind the special needs and circumstances of small firms. Our consultations were very helpfully supplemented by seminars with industry and environmental groups arranged for us by the CBI and Green Alliance.

12. We have drawn heavily on the work of others who have looked already at these questions. I should like to express a particular debt to the Advisory Committee on Business and the Environment, whose report *Climate Change: A Strategic Issue For Business*[5] provided an invaluable starting point for our own review, and with whom I have had some very useful discussions.

13. No clear consensus emerged from our consultations as to the right solution. Responses to our consultation document revealed a very wide spectrum of opinion. (See Annex A.) But having listened to all points of view, my personal belief is that economic instruments do have a role in improving the business use of energy in the UK and contributing to our climate change commitments.

14. This report explains my reasoning and sets out some recommendations on how I think this finding should be taken forward.

15. These recommendations should not be seen as any kind of blueprint for action. Next steps are for the Government to decide in the light of its overall programme. Whatever course is taken I would expect further intensive consultation and debate with interested parties. This is a highly complex area; mine has been necessarily only a brief survey.

16. I view my recommendations in the nature rather of parameters which I would expect Government to follow if it does decide that economic instruments have a role to play. I hope they and the supporting material we have assembled in this report take the debate forward, building on the contributions of ACBE and others in this complex field.

Emissions trends

17. On published projections, UK emissions of greenhouse gases are likely to be about 7 per cent below the 1990 baseline in 2010 – the middle of the Kyoto commitment period of 2008-12. According to the Government's climate change consultation paper, revised road traffic forecasts, including further measures in the transport sector, could mean a further cut of up to 3 per cent.

18. Looking at the individual components of the Kyoto six-gas basket, the Government's published projections show that carbon dioxide emissions are likely to continue to fall until some point in the next decade at which point they will start on a rising trend. Emissions of methane and nitrous oxide will fall sharply and should stay lower, making a major contribution to the overall fall in greenhouse gas emissions.

Table 1: Greenhouse gas projections

	1990 (MtC equiv)	2000 (MtC equiv)	2010 (MtC equiv)
Carbon dioxide	168	157	163
Methane	25	19	16
Nitrous oxide	18	11	12
Hydrofluorocarbons	4·2*	1·2	1·6
Perfluorocarbons	0·2*	0·1	0·2
Sulphur hexafluoride	0·2*	0·3	0·3
Total greenhouse gas emissions	216	189	194

*1995 baseline used for HFCs, PFCs and SF6

Source: UK Climate Change Programme: Government Consultation paper

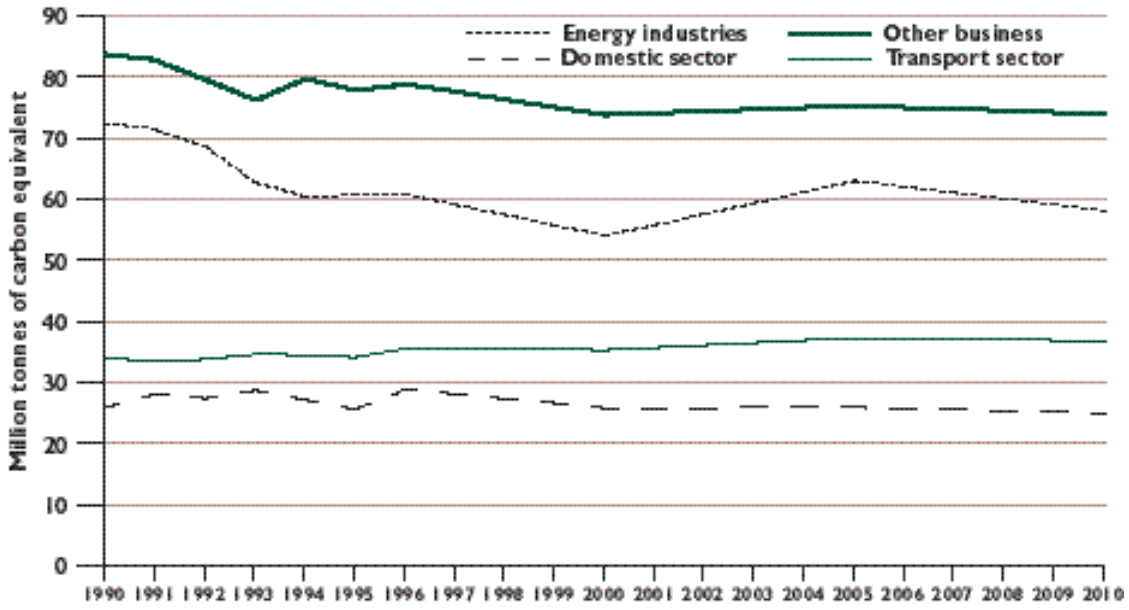
19. The main reductions in emissions since 1990 have taken place in the energy and business sectors, with the biggest effect coming from fuel switching in electricity supply. After 2000 the

[5]Climate Change: A Strategic Issue for Business. A report presented to the Prime Minister by the Advisory Committee on Business and the Environment, 31 March 1998.

falling trends are expected to flatten out or reverse. Domestic emissions decline slightly and transport is on a rising trend to 2010.

20. Figure 2 maps the substantial progress that industry has made to date. But more will certainly be needed from all sectors if we are to have sufficient headroom to be sure of hitting our legal Kyoto target, or to move beyond it towards the Government's 20 per cent domestic carbon dioxide goal. The Government will want to consider what it is reasonable and cost-effective to ask business to do in the light of its projections and the contributions of other sectors.

Figure 2: Greenhouse gas emissions by source; projections to 2010



Source: Department of the Environment, Transport and the Regions

21. Beyond 2010 emissions of all greenhouse gases apart from methane are predicted to resume a rising trend, so that keeping emissions down in order to meet future, tougher rounds of targets may be much harder than reducing them in the first place.

22. Carbon dioxide emissions in particular are predicted to rise. Currently close to 30 per cent of the UK's electricity needs are met through nuclear power. Though it has great advantages in this context as a non-carbon emitting electricity source, I am aware that people have other concerns about nuclear power. It is anticipated that most of the existing stations will retire in the period 2005-20, and few commentators expect new nuclear plant to be built to replace them. As nuclear's share of the electricity market falls off after 2010, the UK will have to work harder just to achieve the same emissions level.

23. Over this longer term, action to tackle emissions of carbon dioxide will be key. In the absence of further measures, carbon dioxide emissions are projected to account for 84 per cent of our total greenhouse gas emissions in 2010 compared with 78 per cent in 1990. Tackling carbon emissions in industry means switching to less carbon intensive forms of energy generation and minimising wasted energy.

Energy use

24. Can industry do much more about its energy use and carbon dioxide emissions? In the light of the reductions already achieved one might wonder. In particular one might question what scope there could still be for savings in sectors for whom energy is a high proportion of their costs – the so-called energy intensive industries – who clearly already have a big incentive to economise. Annex C details patterns of business energy use and costs by sector.

25. However, there is some evidence to show that there is scope for further energy efficiency and emissions reduction in business. The Task Force has looked in detail at work carried out by the Energy Technology Support Unit (ETSU, part of AEA Technology plc) on just this issue. ETSU's core business is as consultants on energy efficiency. They are therefore as well-placed as anyone outside firms themselves to make a judgement about the energy efficiency opportunities available.

26. ETSU's work appears to show that there is *considerable scope* for cost-effective energy saving and carbon dioxide abatement measures in all sectors, including those identified as energy intensive. In a number of sectors – including, from amongst the more energy intensive industries, non-metallic minerals, non-ferrous metals, and paper – ETSU say there are very substantial opportunities for cost-effective reductions in emissions and energy use. Adoption of measures identified by ETSU as cost-effective in their own right could reduce energy demand by in excess of 15 per cent in each of these industries. If all technically possible measures were adopted, the scope for reductions in energy demand is generally much greater. ETSU's findings are set out in full in Annex E.

27. These estimates are just that: estimates. Much turns on the definition of 'cost-effective'. Though the investments ETSU identify may deliver a return, businesses may be able to get higher returns on other kinds of projects. Or there may be other good reasons why industry does not pursue these apparently cost-saving opportunities – companies face many demands on their stretched resources. I would not want to place too much weight on the precise numbers. But these are interesting findings. And the Task Force notes that ETSU's work does seem to be very well regarded by industry: many business respondents to our consultation document quoted from ETSU's work in estimating benchmarks and potentials for emission savings in their sectors. In our consultations many business representatives acknowledged that their industries were by no means yet pushing at the technological frontier on energy efficiency.

28. One finding worth emphasising is the proportion of relatively cost-effective savings which may be available to smaller businesses and the commercial sector. The Department of the Environment, Transport and the Regions estimates that even on the most conservative assumptions, up to an additional 3.5 million tonnes of carbon could be saved in this sector at *a net benefit* to firms themselves. Such high figures are not implausible. Smaller firms are unlikely to have dedicated resources or technical assistance in energy or environmental management. Their energy use and carbon dioxide emissions are not currently regulated.

29. The general message is that there remains some scope even in energy intensive industries, and there is quite a lot in firms outside that group, for energy savings and emissions reductions which are relatively cost-effective. Far from having done it all already, there is some evidence to show that industry may actually have lost ground, and that energy efficiency has fallen off slightly, since 1989. There are a number of explanatory factors, including turnover in the capital stock and changes in the sectoral mix of industrial output. The shift is undoubtedly also due, however, to the effects of lower energy prices, pointing up a link between prices and energy use which I will return to in my discussion of the instruments below.

The instruments

30. There are several ways in which the Government might seek carbon emission reductions from the industrial and commercial use of energy. In practice a mixed approach, involving a range of measures, is likely to be necessary to secure reductions of the scale required. The interactions between the different instruments in play will need to be carefully considered, to ensure that unforseen effects do not leave any one sector under a disproportionate burden overall.

31. **Regulation** is already part of the picture. Carbon dioxide emissions are regulated in those industrial sites subject to the Integrated Pollution Control regime. From next year to 2007 the EC Integrated Pollution Prevention and Control Directive (IPPC) will come into force across 6,000 industrial installations in the UK. Among its many provisions the Directive requires that installations be operated in such a way that "energy is used efficiently".

32. IPPC will deliver some emissions reductions from heavy industry. But it will not tap the potential of smaller firms or commerce. Most small and medium-sized industrial firms and all commercial premises will be outside the scope of IPPC. Regulation is not likely to be the most efficient way of trying to unlock savings from this sector, though it is here that some of the most cost-effective opportunities for saving energy and cutting emissions may lie.

33. Even among those companies who will be subject to IPPC, however, there are good reasons for thinking that the Directive will not by itself achieve the economically efficient level of emissions reductions. The background is explained in detail in Annex D below.

34. One reason is that since failure to meet requirements is a prosecutable offence, IPPC authorization limits may tend to be a conservative interpretation of what can be achieved, especially by new technology, where the imbalance of information between company and regulator is likely to be especially acute. To the extent that IPPC companies are doing less than they could cost-effectively relative to other sectors, then the cost to the economy overall of reducing emissions will be higher than it need have been.

35. More importantly, though, IPPC is *existing process-based*. It will require firms to tighten up their existing processes, but it will not provide an incentive to look at whether instead to reduce operating periods, to retire plant early, or to switch out altogether of more carbon intensive technologies or lines of business into less carbon intensive ones. To take an actual example, if a pipe is currently made from primary steel there could be several options which would reduce the energy consumption of its manufacture: making the steel process more efficient, making the pipe from less steel, making the pipe from recycled steel (which is less energy intensive) or even making the pipe from a completely different material like plastic. IPPC will focus on making the primary steel process more efficient but would provide no incentive for the market to take up the other options. In practice these may actually have been better for the environment as well as cheaper in the long run for the economy.

36. **Voluntary agreements** may also offer prospects for achieving savings in certain sectors. A voluntary approach may help to build co-operation. It will aid networking and sharing of best practice within sectors. The Chemical Industries Association has already entered into a voluntary agreement with Government to improve its specific energy use (energy consumption per tonne of product) by 20 per cent on its 1990 level by 2005. I understand the Government is discussing possible initiatives with other sectors and I hope that more agreements will be reached as a result. However, voluntary agreements have limitations: they will only be practicable in relatively well-organised sectors with a small number of large players; and, being voluntary, there is no guarantee they will deliver. Because of the imbalance of information between firms and the regulator, it is only fair to recognise that the Government cannot be sure that an agreement is offering the right deal in terms of emissions reductions. To the extent that agreements fall short, other sectors of the economy and industry will have to do proportionately more. For all these reasons I would not expect them to be the mainstay of the Government's programme.

37. Some industry sectors have acknowledged that the Government will probably not wish to rely on purely voluntary agreements as the means of delivering a legal commitment, and have begun to raise the possibility of 'negotiated', legally-binding agreements. The difference is that Government would be able to impose penalties if the required standards were not met. The very significant agreement on carbon dioxide reductions recently contracted by European car manufacturers with the European Commission through their trade association ACEA moves

towards this model. **Negotiated agreements** could be a flexible approach which I hope will be examined in detail. However, even this model would still have some of the drawbacks of regulation. It would suffer from imperfect information on the part of the Government regulator. Once the deal was struck there might be no reward to companies who did better than expected. I suspect that such agreements would require a heavy investment of time and resources to negotiate. I believe agreements are only likely to have any prospect of success in cohesive sectors with small numbers of large players.

38. **Subsidies** are contributing by stimulating the development of renewable generation technologies in the energy market. With support from the Non-Fossil Fuel Obligation (NFFO) the price of renewably generated electricity has fallen to a level where for some technologies it is, or is nearly, cost-competitive with traditional fuel sources. I firmly believe the increased use of renewable, low-carbon generation will become of crucial importance in tackling climate change in the long-term. In looking at new instruments I have had particularly in mind the need to find solutions which encourage further moves towards renewables, and which do not disadvantage Combined Heat and Power (CHP) technology.

39. The question put in our consultation document was whether **economic instruments** have a role alongside these other instruments. We noted their theoretical advantages of efficiency, and the way in which an economic instrument can take account of varying abatement costs between companies, minimising the impact on industry overall. We noted that decisions about how best to find ways of cutting emissions are decentralised to firms, who are best placed to know. We noted how unlike regulation or negotiated agreements economic instruments provide a continuing financial incentive to reduce emitting activities and expand beneficial activities, rewarding innovation through the bottom line. The issue for me and the Task Force has been whether an instrument could be implemented in such a way that these theoretical advantages could be realised in practice, so minimising the threat to UK firms' competitiveness compared to other less flexible measures.

40. Our consultation document focussed on two main options: a system of emissions trading and a tax. We also invited suggestions for other market mechanisms. A summary of consultation responses is at Annex A. No other potential instruments emerged, though the responses revealed a very broad range of views about both tax and trading, on the principle and on their detailed design. Tax and trading have many similarities. Both work through the price mechanism, incentivising reductions in the emitting activity by raising its cost. But there are significant administrative and practical differences.

41. My conclusions on each option are set out below. **In summary, I see a role for both as part of a package of measures, alongside existing regulation, voluntary and negotiated agreements, and other measures, and appropriate action on the part of other sectors. However, any measures must be subject to careful design in order to protect the competitiveness of British industry and maximise the environmental benefit.**

TRADING

42. The issue over tradeable permits is not so much *whether* they have a role in helping the UK to meet its targets as *how much* and *when*. Trading is already on its way. A system of international greenhouse gas emissions trading is provided for in the Kyoto Protocol. The Parties are negotiating now the rules and modalities which will govern it. Emissions trading at an international level will be a reality by 2008, when the commitment period for meeting countries' Kyoto targets begins.

43. The Protocol also allows emissions reductions credits to be created by implementing projects in other countries. These projects can be in developed countries (under 'Joint Implementation') or developing countries (under the 'Clean Development Mechanism'). Again, the rules and modalities for the operation of these mechanisms remain to be decided. But I have no doubt if properly designed they will offer significant opportunities for governments – and business – to achieve environmental benefits at lower cost.

44. The Task Force has studied the theory of tradeable permits and sought views on emissions trading in its consultation paper. Like many of those who responded, we were impressed by permit trading's theoretical advantages. 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. We take the example of the successful sulphur trading scheme operating in the US as showing that these theoretical advantages can, in the right circumstances, be realised in practice (though we note that this scheme took a long time – almost ten years – to develop). The scheme is further described in Annex B.

International trading

45. I am therefore very pleased that international trading will be available to the UK as part of the solution to achieving its commitments. This is an international solution to a global problem. Trading will directly encourage the structural changes in the global economy which will be necessary if climate change is to be stabilised. By providing access to cheaper emissions reductions in other countries it is likely that international trading will reduce the burden of compliance for all Parties to everybody's benefit.

46. I should say I regard it as crucial that individual companies are able to trade in their own right. Some would prefer trading to take place on a government to government basis only. But this would not unlock the full potential of trading. Firms, not governments, are best able to spot abatement opportunities and best placed to decide whether it is most cost-effective in their individual circumstances to reduce their own emissions or buy permits. Unless firms are allowed to trade in their own right, trading will not be as flexible or cost-effective an instrument.

47. Negotiations on the design of an international system are ongoing. Britain should continue to play a leading role. The UK can take pride in its ingenuity and experience in market making. The Government will want to channel that expertise to make sure we end up with a trading system which will meet the UK's main objective. I take this to be a workable scheme which makes room for business involvement and is both environmentally effective and economically efficient.

A domestic UK trading system?

48. There are clearly formidable problems to be faced in putting an efficient international trading system together. However, the country which comes up with solutions will have most influence over design. Because of this, the Task Force considered very carefully whether to recommend that the UK should launch its own domestic trading scheme in advance of an international system being developed. This would inform our negotiating position on trading. And we were interested in the suggestion that it could give UK companies and intermediaries an edge as international trading went live.

49. We posed the question of whether the UK should set up its own domestic scheme in our consultation paper. Some consultees were attracted to this. There was strong support from the energy industries and the City.

50. But as many business respondents were daunted by the difficulties. Some, especially among the big energy users, were sceptical about how well a UK scheme would work in practice. Others were more enthusiastic in principle but pointed to the length of time which it could take to sort out knotty questions of design. Responses added to the list of issues needing resolution which the Task Force had already identified in its analysis.

51. Consultees offered the following reasons why it might not be sensible to move too quickly to set up a UK scheme in advance of international trading.

Compatibility with international system

52. Some consultees were concerned about the potential dangers of establishing a system now in the UK which might turn out not to be compatible with the international scheme when it is launched. They felt it would be better to wait until the details of international trading are clearer. Many substantial issues of design are still open at an international level. Respondents suggested this opened up a prospect that the rest of the world might ultimately decide not to follow a UK system's lead on some important aspects. At worst, the UK could have to dismantle its system and start again. Clearly this would be a very difficult and painful thing to do with a statutory scheme where companies had paid real money for the domestic permits. In practice I hope that such a degree of incompatibility would not be likely. The onus would be on Government to ensure that the design of any domestic scheme proceeded in step with international developments as far as possible.

Banking

53. One advantage for participants of an emissions trading scheme is the ability to 'bank' permits for future use, but this could be problematic if it were part of a system set up in the UK in advance of 2008. If firms were allowed to 'bank' permits before 2008, which they then used during the Kyoto commitment period, the increased emissions could jeopardise the UK's ability to meet its target. Any pre-2008 domestic system would have to take account of this issue, and it is likely that pre-commitment period banking would need to be strictly limited.

54. These arguments by themselves do not appear to me conclusive. But I am persuaded that the practical issues of design would take considerable time to settle. The following issues emerged as the most crucial for a fully fledged domestic greenhouse gas emissions trading scheme.

Coverage

55. Our analysis led me very quickly to the conclusion that participation in trading will probably never extend to the small business sector. The regulation and administration associated with trading is also bound to make it less attractive even to larger companies for whom energy is not a high proportion of their costs. Over time, as a mature market developed, I would expect

the emergence of brokers to reduce the costs of actual transactions. But participants will still need to have in place the means to monitor and verify their greenhouse gas emissions, and for the typical small energy user, the costs of such monitoring, and the burden of producing emissions data up to auditable standard, could be prohibitive.

56. Given that trading is unlikely to involve all businesses, the first issue in setting up a scheme is to decide which subset should be covered. If a scheme involves too small a number of players, then the market could be too thin to allow many beneficial trades, making it difficult to correct for any inefficiencies in the initial permit allocation. But as implied above, the administration involved in regulating trades is likely to place an upper limit on the number of participants. A scheme which started with too large a group could run the risk of being overwhelmed by its own bureaucracy.

57. Some consultees sought to avoid both problems by suggesting that a scheme could build up incrementally, starting with a small group whose emissions are already monitored and who could cope with the administration, and gradually extending into other sectors over time. Several consultees picked up ACBE's suggestion that the most likely place to start was with a subset of the group of installations covered by IPPC. Most of these sites would be large enough to have the expertise and not be overburdened with the compliance costs. The existing regulatory requirements provide a ready made framework for monitoring and control. I believe this incremental approach may offer the best prospects for a scheme's successful development, though it is not without its problems. The most important of these is discussed in the paragraphs below on setting a target level of emissions for a scheme.

58. I was not attracted to the other alternative solution proposed by some respondents to our consultation paper, of issuing permits at the primary fuel level. Their suggestion was that as trying to permit large numbers of emitters would never be practical, a better way of trying to secure wide coverage at least of fossil fuel inputs to the economy would be to tackle the issue upstream, by requiring primary fuel producers to hold permits to cover the carbon content of the fuels they extract. Such a scheme would only involve the relatively few fossil fuel producers, making monitoring and administration easier. However, there would be several major difficulties for a domestic system set up on this basis, not least the question of imports. I have seen no convincing explanation of how one could require foreign producers to hold permits for fuels sold into this country without falling foul of trade rules which prevent the imposition of quantified limits on imported goods.

59. Almost all suggestions for the initial coverage of a trading scheme involving carbon users have included electricity generation. This surely makes sense. But the Government has of course recently announced a package of wide-ranging reforms aimed at removing distortions and improving competition in the electricity market. The Government hopes these reforms will ensure diverse and secure energy supplies into the future through the proper functioning of market forces. However, they represent a period of radical change for the industry. It may be sensible to let these reforms bed down before introducing a further novel and significant reform in the form of permit trading. The Government would also no doubt wish to consider the position of electricity and competing fuels in determining the coverage of a trading arrangement.

Target level of emissions

60. Emissions trading schemes' advantage for the regulator is that they provide certainty over the overall level of emissions reduction in the sectors affected. But this certainty can be a double-edged sword. Setting the target to be achieved by this group involves making a judgement about what it is reasonable to expect them to deliver over the lifespan of their permits. Once that judgement is made, and assets have been handed out or sold, it is extremely difficult and inadvisable to reopen it. But there is every possibility of getting it wrong. Emissions reductions in those sectors might turn out to be more expensive than previously thought, so that with hindsight one might have preferred to seek the abatement from other parts of

industry or the wider economy. Or the emissions reductions could be cheaper than one thought, so that with hindsight one might have wanted them to do more so that others could do less. Clearly the crucial relationship is between the lifespan of the permit and the initial target set.

61. This is a problem particularly for a limited scheme involving a small number of players. It is unlikely to come up in the context of a wider scheme, where there is greater flexibility to share out a target, so that the risks of serious distortions are reduced. Nor for the same reason would it be likely to be a problem in a scheme linked into the international system. But in a narrow scheme, the regulator in setting the overall target is effectively making a judgement about what level of output those sectors can produce over the lifespan of the permit. This can clearly be a difficult thing to get even approximately right.

62. The problem could also arise in a scheme whose coverage is built up incrementally like that outlined in paragraph 57 above. As the regulator adds in a new sector, he will have to decide on the number of permits which must be added into the existing system to accommodate it and hence on a reasonable target level of emissions for that individual sector. This will involve effectively making a prediction of the output over time of that group of firms. At this very narrow focus there is a greater risk of distortions, as allocation may not correspond to the most dynamic sectors. If the regulator gets it badly wrong there could be unnecessary fluctuations in the market price of permits. Problems of this kind, coupled with a potential lack of liquidity in a narrow scheme, could mean a trading system designed like this did not realise the advantages of an economic instrument.

63. Bound up with the issue of a target level of emissions for the scheme is the question of the mechanism by which that target level might be varied over time. Many consultees were attracted by the idea of the emissions cap starting fairly high and ratcheting down in due course as industry adjusted. Two mechanisms were suggested in the responses: shorter lifespan permits regularly reallocated by periodic auctions, with some being withdrawn from sale each round; or longer-lifespan permits, but with face values that declined according to a known, fixed pattern over time. I can see advantages and disadvantages to either method. In deciding which to go for Government would need to strike a difficult balance between the benefits of regular auctions in safeguarding competition (see paragraph 70) and the need for a reasonable degree of certainty into the future on the part of businesses as they plan their investments. The worst thing a permit system could do would be to discourage new capital investment by increasing uncertainty.

Allocation

64. Of most concern to consultees was the question of permit allocation. There were widely differing views about how best to allocate permits efficiently and effectively, once the overall target for a trading scheme was set.

65. Some consultees favoured a so-called **'grandfathering'** method, under which firms' emissions entitlements would be based on their emissions in a base year (or the average of a number of years). This method has attractions as being relatively simple, at least in the case of those companies for whom historic data is available.

66. However, I and the Task Force were concerned that there appears to be no simple way of guaranteeing new entrants a level playing field against the advantages such an allocation system gives to incumbents. Energy users who responded to our consultation were particularly worried that it might bolster market power in the electricity generation sector, to the detriment of consumers. They were very keen that any system should not work against the grain of the Government's recent reforms to the electricity market – a key element of which is to take practical opportunities to reduce market power in generation – by using an allocation method which discouraged competition.

67. Another concern about 'grandfathering' raised with us in our consultations, and one which I share, is the problem of equity. It is difficult not to feel that such a system would unfairly favour the least efficient firms and firms with declining output as against new or growing firms and firms which have already undertaken emissions reductions. The scheme could be perceived as handing out windfall gains, in the shape of valuable permits, to failing companies or to those who had been slow to act before. Some consultees were concerned that the cyclicality experienced by their industries could also complicate choosing a baseline.

68. There are ways one might try to adjust allocations so as to take account of considerations like these. We raised the option of **'benchmarking'** in our consultation document. This would involve the regulator making a judgement of what it would be fair to expect each firm to take on as a target, based on knowledge of what the best in its sector are doing, and that firm's individual circumstances. On reflection, however, and in the light of consultation responses, I believe benchmarking may only have a role as a guide to allocation in sectors which are reasonably homogenous, where it is possible objectively to compare the performance of different firms. Elsewhere I think it will be too difficult for the regulator to acquire the data with which to scrutinise each case.

69. In my opinion, these considerations do point quite strongly towards **auctioning** permits as the best way of ensuring equity among participants (though see paragraph 63 above). Instead of relying on a fallible regulator, allocation decisions would be left to the market. Auctioning permits would incentivise firms to make accurate assessments of the relative cost-effectiveness of emissions abatement and bid accordingly. As with a tax the revenue could be recycled to the affected industries in some form.

70. However, it is clear from the responses to our consultation that many of the most likely players in a trading scheme dissent from this view. Their concerns must be taken seriously as I believe it will be essential to the success of any system that the permit allocation method commands consent among participants. A possible compromise might be built around some sort of **hybrid** scheme, aimed at combining the advantages of the other main methods of allocation with some element of auctioning in order to safeguard competition. However, given the spread of opinion which our consultation has exposed, I am bound to say I think that achieving a consensus about allocation, even around a hybrid model, is likely to be very difficult, and that this more than anything will make preparing the ground for a statutory trading scheme in the UK a time-consuming process.

Monitoring

71. Monitoring and verification are at the heart of any successful trading scheme. It is vital to get them right. Emissions of carbon seem relatively tractable. Because of the absence at present of economically viable carbon scrubbing technology, we know approximately what carbon dioxide emissions are produced by each unit of fossil fuel energy consumed, and so calculating emissions from fossil fuel use is relatively straightforward. Some larger firms already provide information on emissions in their environmental reports. Of course, the regulators would need to be convinced that the reported data was of sufficiently high quality, and such reporting would have to be combined with an independent audit of participating firms' energy use. In addition (as for a tax), allowance would have to be made for fuels that are not combusted, but are used in the manufacture of other products like chemical feedstocks. For large firms, this need not present great obstacles. However, including other greenhouse gases in the scheme might present more significant monitoring and verification problems. Some of these gases are difficult to measure accurately; others are embodied in products, with the timing of eventual emissions uncertain. My impression is that we have some way to go before we would be ready to implement trading in the UK across all six gases listed in the Kyoto Protocol.

Compliance

72. Nearly all commentators agree that a greenhouse gas emissions market would have to be backed by a robust compliance regime. But other than the suggestion that compliance could be linked in some way to the IPPC permitting regime for those companies within it, our consultation threw up few specific ideas about how enforcement should be tackled. Decisions on what sort of compliance mechanisms are necessary and appropriate are clearly interrelated with decisions on the scheme's coverage, on the level of ambition of the overall target set for it, and on the allocation method.

73. I believe that all these problems – target level, allocation, monitoring and compliance - are tractable. But I accept they will take time to resolve. That permit systems can be time-consuming to design and develop was one of the lessons I drew from US experience of sulphur trading. In particular I suspect it may require extensive consultation to arrive at an arrangement for allocating permits which commands consensus among participants. In the light of responses to the consultation paper I believe it may not be realistic to expect a statutory UK scheme to be operating much before international trading begins with the Protocol commitment period in 2008.

74. **This leads me to the conclusion that it may not be sensible for Government to introduce a statutory scheme in the UK at this stage.**

75. However, this absolutely does not mean that the Government and business should abandon work on trading. I believe an international scheme will be among the most cost-effective ways of meeting present and future climate change commitments. The same issues of design will arise with British participation in international trading. They will have to be settled in due course before we can take part.

76. Precisely because I believe the detailed issues of design will take some time to settle, I think intensive work should start now. It will be vital not to lose momentum if we want to reap the real benefits of international trading. **I therefore recommend that Government should step up its consultation with interested parties focussing especially on resolving the issues identified above. Strong business input to design of international trading will be essential. Such consultation should inform the UK's negotiating position as well as developing expertise domestically so that British firms are ready and our financial institutions well positioned to lead in these new markets.**

77. I have been impressed by what I have heard of BP's internal trading scheme, and am pleased that others such as Shell, the Association of Electricity Producers and the International Petroleum Exchange are already developing their own thinking on the issues. Provided that considerations of commercial confidentiality could be set aside, a 'virtual' pilot with interested players would be an opportunity to experiment with the detail of a trading system and allow firms to practise using it, without the dangers of legislating ourselves straight into a particular regime. In particular, it would be an opportunity to model the real effects of different allocation options, so as to inform what I suspect, as I have said, will be a very tricky set of decisions.

78. Though I think a statutory UK scheme will probably be unrealistic much in advance of 2008, I am convinced of the advantages which actual practical experience of trading before then would bring. **I recommend that the Government seriously consider a dry-run pilot with interested players as soon as possible, as a means of learning lessons for when an international scheme begins.**

Is there a role for a tax?

79. International emissions trading therefore offers good prospects for the future and will form part of the long-term solution to reducing greenhouse gas emissions in the UK.

80. If the Government is looking to the industrial/commercial sector to do more to meet its current emissions targets, then there are good reasons for considering the role a tax might play.

81. There are three main attractions of a tax:

- first, as an economic instrument, a tax works through the price mechanism and thereby allows individual businesses to determine the appropriate response. Those businesses who are able to reduce energy use or emissions at low cost – less than the tax – are likely to do so. Others, who can only reduce their energy use or emissions at high cost, will tend to maintain their demand and pay the tax. This flexibility offers the potential for delivering energy use or emissions reductions in a cost-effective way (see Annex F for estimates of the emissions savings resulting from a tax);
- second, a tax could act as a signal to business and begin to influence investment patterns *well ahead* of the commitments made for the period 2008-2012. I note, in particular, the acceptance by ACBE that "an economic instrument in the form of a tax may be necessary to meet the Government's targets"[6];
- third, with appropriate design, a tax could help improve energy efficiency in small and medium sized enterprises (SMEs), the commercial sector and non-energy intensive industrial firms. Taken together, these firms account for around 60 per cent of total carbon dioxide emissions from business, and may offer scope for significant improvements in energy efficiency and reductions in emissions. For many of these firms participation in an international trading scheme may simply not be practical.

82. I am particularly aware from our consultations of the desire on the part of business for a clear indication of the long-term direction of policy to help planning and investment decisions. In my view, giving such a signal would help businesses plan ahead and could enhance the environmental effectiveness of a tax.

83. Of course, for many small firms, financial constraints may inhibit the take-up of the energy saving opportunities that exist already (although, I note that the work of ETSU suggests that many cost-effective improvements are possible even with energy prices at their current, relatively low, levels.) A fully recycled tax, which increased the price of energy relative to other factors of production, but did not impose additional costs on business as a whole, should encourage SMEs to exploit these opportunities, particularly if supported by well-targeted energy audits/advice on how best to do so.

84. In theory, these improvements in energy efficiency could be achieved either through trading or regulation. However, I doubt whether it will ever be feasible for the bulk of SMEs to participate in the international trading scheme. And applying detailed regulations on energy efficiency to this sector would, in my view, be generally an inefficient and bureaucratic way to proceed. With appropriate design, a tax may be able to unlock the significant potential savings from the SME sector in a relatively cost-effective way.

[6] Climate Change: A Strategic Issue for Business, Advisory Committee on Business and the Environment, March 1998.

85. However, like any other instrument, a tax would need careful design if it were to deliver emissions savings without damaging the competitiveness of British firms.

86. In my view, the potential impact of a tax on the competitive position of British firms is of central importance, both in the short term, given the current economic climate, and over the longer term. I have listened carefully to the views expressed on this issue through our formal consultations and other representations.

87. The overall impact of a tax on competitiveness will depend, among other factors, on:

- the size and nature of any tax, including any special treatment for energy intensive industries;
- the way in which any revenues are recycled to business;
- what measures other countries introduce to meet their emissions targets.

88. My suggestions on the detailed design issues are set out below. At this point, I simply note that, if the revenues are recycled in full to business, then the first-round impact on business costs across the economy as a whole will be broadly neutral[7]. Within that aggregate picture, there will of course be some firms or sectors whose costs increase and others whose costs decrease, the scale and nature of the effects depending on the method of recycling.

89. The position of British industry *relative to our main competitors* will depend on what measures other countries introduce to meet their own emissions targets. Annex B sets out the international context and gives details on:

- the emissions targets faced by some of our main competitors;
- the economic instruments already introduced in other countries;
- what we know about other countries' future plans.

90. I note, in particular, that:

- on current projections, most OECD countries need to enact new measures to meet the emissions targets set under the Kyoto Protocol;
- since 1990, six European Union countries have introduced explicit taxes on the carbon or energy content of fuels;
- the new German government has recently announced details of an energy tax package, and the Italian government proposed a carbon dioxide tax in its latest budget.

91. I am also aware of the draft EU Energy Products Directive which, if adopted, would require all Member States to apply minimum rates of tax to energy products, and would lead to greater harmonisation in the tax treatment of energy products across the EU. (At present, there is significant variation in post-tax gas and electricity prices faced by industrial customers across the EU, with prices lower in the UK than in many other EU countries – see Annex G for details.)

92. It appears then that a number of countries see a role for tax in meeting the challenges presented by climate change. We should aim to learn from their experiences. We should also seek to exploit the opportunities that arise by being at the forefront of developing new energy saving technologies.

93. Aside from the potential impacts on competitiveness, concerns have been expressed about the ability of a tax to reduce emissions. Some have argued that the effect of a tax on emissions

[7] The eventual impact on the economy of a change in the structure of taxation will depend on a number of factors, including how the tax is recycled, and the response of firms to that change.

is *uncertain* and that this puts tax at a disadvantage compared to trading. Others have argued that a tax will only have a very *limited* effect on energy use or emissions, since further efficiencies are limited by physical or financial constraints.

94. The Task Force has considered these arguments carefully. I recognise that there is a degree of uncertainty surrounding the impact of a tax on emissions. However, I do not necessarily consider this to set tax at a disadvantage relative to trading. Indeed, as already noted, the appropriate target for a trading scheme to deliver in terms of reductions in emissions by industry and commerce is not easy to determine. In my view, one of the attractions of a tax is that it can be adjusted, if necessary, in the light of experience. Reallocating permits could potentially be an administratively complex and costly exercise.

95. Regarding the ability of a tax to deliver emissions reductions, it was noted above that the work of ETSU suggests there is considerable scope for further cost-effective improvements in energy efficiency across industry (see Annex E for details). A tax should help to stimulate the implementation of cost-effective measures as well as to bring additional technically possible measures into the cost-effective group.

96. Further evidence on the likely effects of a tax on energy use and emissions is given in Annex F, which presents estimates from different models on the responsiveness of energy demand to changes in real energy prices. For example, the latest version of the DTI energy model suggests that a 10 per cent increase in real energy prices leads to a fall in industrial energy consumption of around 3 per cent. By comparison, the Cambridge Econometrics model would predict a fall in industrial energy consumption in this scenario of about 5 per cent.

97. However, I recognise that for some firms, physical and/or financial constraints may limit the further efficiencies that are possible. I also recognise that the impact of any tax would be greater in energy intensive firms. Given these considerations, I take the view that, if a tax were introduced, then there may be a case for offering some form of special treatment for the most energy intensive firms.

98. Clearly, it will also be important for the Government to consider carefully the interaction between different economic instruments to avoid placing undue burdens on industry. However, it would be premature to speculate at this stage about the nature of that interaction when the details of the international trading scheme are not known.

99. In my view, these arguments about the potential impact of a tax on competitiveness, particularly for energy intensive firms, stress the importance of any tax being subject to careful design. They do not, on their own, invalidate the case for using a tax as part of a package of measures designed to help reduce greenhouse gas emissions.

100. **My conclusion is that there probably is a role for a tax if businesses of all sizes and from all sectors are to contribute to improved energy efficiency and help meet the UK's emissions targets.**

101. I am also of the view that, in order to help businesses plan for future investment and maximise the environmental impact of a tax, a clear signal should be given of the long-term direction of policy, with changes in the rates of tax made in a gradual and predictable way. This need not preclude Government monitoring and taking account of progress made towards its targets when setting tax rates.

102. But any tax must be designed in a way that protects the competitive position of British industry. To this end, **I recommend that:**

- **the revenues are recycled in full to business;**
- **consideration be given to special treatment of energy intensive industries;**
- **any measures are subject to detailed consultation about their design.**

What form might a tax take?

103. As explained above, I see a further round of consultation on detailed design issues as being essential before any new measures could be introduced. Below, I simply offer my thoughts on the broad shape any tax might take and highlight the areas where further detailed work and consultation would be required if a decision were taken to proceed with a tax.

104. The Task Force has received a number of suggestions on the possible design of a tax. I note, in particular, the ACBE recommendation that any tax introduced should be directed at carbon dioxide emissions by business and domestic users of energy.

105. I can see that this is as an attractive option in principle. It would target carbon dioxide emissions directly and, if applied 'upstream' to the use of primary fuels by industry and commerce (including fuels used by electricity generators in the generation of electricity), could encourage fuel switching on the part of those businesses towards low carbon fuels.

106. However, an 'upstream' tax could conflict with other objectives of Government policy. For social policy reasons, it is the Government's intention not to introduce new taxes on *domestic* consumption of fuel and power. An 'upstream' tax could impact directly on domestic customers if the electricity generators attempted to pass on the higher costs in the form of higher prices. Even with a complex system of rebates, there would be no way of guaranteeing an exemption for domestic customers[8]. Moreover, a complex system of rebates would add to the regulatory burdens on this sector at a time when the Government is seeking to promote competition and diversity of supply.

107. The stage at which the distinction between industrial/commercial use and domestic consumption is clearest is the point at which it is sold to the final consumer. This suggests the need to apply the tax 'downstream' on supplies of electricity to final industrial and commercial users, since only at the point of sale is the identity of the final customer known.

108. **Given current policy objectives for the domestic sector, the leading option would therefore appear to be a 'downstream' tax on supplies of energy products and electricity for final use by industrial and commercial consumers.**

109. 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.

110. 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 (see Annex B).

111. 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.

[8] There may, of course be indirect effects on the domestic sector if the effects of a downstream tax get passed on in the form of higher prices.

112. A 'downstream' tax could take a number of forms. A detailed blueprint could only be determined through further work and consultation. However, I have identified the following issues as being of central importance:

Specific or ad valorem?

113. The tax could be applied as a *specific tax rate* per given quantity of carbon or energy, or as an *ad valorem tax* on the final supply prices of the energy sold. Applying a specific tax rate makes it easier for the rate of tax to be tied to its environmental aims. The link between the tax and its environmental aims would be less clear in the case of an ad valorem tax, since there is no necessary correlation between price and either the carbon or energy content of fuels. In addition, an ad valorem tax could give rise to inappropriate signals since the amount of tax paid (and, by implication, its behavioural impact) falls as energy prices fall. Indeed, an ad valorem tax would tend to exaggerate both price falls and price rises.

114. I am therefore of the view that any tax should be levied on the basis of a *specific tax rate* calculated by reference to the carbon content of the fuel consumed or energy used. This is the approach used in other EU countries which have introduced explicit carbon or energy taxes.

Carbon or energy?

115. The tax could be applied to either the carbon or energy content of different fuels used by industrial and commercial customers. A carbon based tax would have the advantage of encouraging some fuel switching (at the margin) amongst final users towards low carbon fuels.

116. However, given the current structure of the electricity and distribution industries, it would only be possible to determine the carbon content of electricity as a broad average. This may limit the extent to which fuel switching might occur.

117. The alternative would be to apply an energy based tax, on a pence per kilowatt-hour basis, derived from the known energy content of each fuel. This would have the advantage of simplicity, although, by not encouraging fuel switching, would be less effective in environmental terms.

118. The consultation paper issued in June asked respondents for their views on whether a tax should reflect energy or the carbon content of different fuels. The vast majority of respondents thought that a tax should reflect the carbon content of different fuels rather than being solely targeted at energy use.

119. Further work would be needed to refine these options before any decisions could be reached. In particular, it would be necessary to investigate in more detail the extent of fuel switching that might occur, and the resulting impact on emissions, under different tax structures. **But, in my view, there is a good case for trying to reflect, at least in broad terms, the carbon content of different fuels in the rates set in order to maximise the emissions savings resulting from the tax.**

Calculating a rate for electricity

120. The generation, transmission and distribution of electricity all involve losses of energy. In order to maintain a level playing field with other fuels, with an energy based tax the rate on electricity should aim to reflect the larger amount of energy input required to deliver the same amount of energy at the point of sale to the final customer. If this were not the case, the tax could result in switching to electricity from other fuels, which could have an adverse effect on energy use and emissions. This issue may not arise if the tax rates set were to reflect the carbon content of all the input fuels used in the generation, transmission and distribution of

electricity. But the issue would arise if the tax rates were set on an energy basis. If the Government did decide to proceed with an energy based tax, it would need to consider carefully the appropriate relativities for the tax rates applying to electricity and other fuels.

Use of fuels as inputs to production of other fuels

121. To avoid double taxation (or taxing domestic/other relieved use), fuels which are an input to the production of another fuel should not be subject to the tax (although CHP plants may be best handled differently – see paragraphs 128-130). This is explicit in the concept of a 'downstream' tax on electricity. But the principle would also extend to, for example, coal used to make coke.

122. There is also the issue of the tax treatment of forms of energy produced as a by-product of another energy use (such as gas from the burning of coke in blast furnaces). It is probably not sensible to attempt to tax them, both for reasons of administrative simplicity and to maintain an incentive to use, rather than waste, such potential sources of energy. Such an approach is consistent with the draft EU Energy Products Directive.

Non-energy use of fuel products

123. I believe it is reasonable that the tax should not apply to non-energy uses of fuel, since the fuel is not burned to release emissions of greenhouse gases. Again, this would be in accordance with the principles outlined in the draft Energy Products Directive and the rules which currently apply to mineral oils. Examples of such use, taken from mineral oils taxation, include products used as lubricants or as feedstocks for the manufacture of plastics or paints. **The Government should examine in further detail how this would work in practice.**

Renewables

124. There are good arguments on environmental grounds for offering tax relief to electricity generated from renewable sources. This would be relatively simple to administer in cases where the renewable electricity is supplied direct to the final customer. However, for electricity not supplied directly, it is not possible to identify at the point of supply to the final customer whether the electricity came from a renewable source. (In effect, a 'downstream' tax would treat electricity generated from renewable sources in the same way as electricity generated from other sources.)

125. At present, therefore, it may not be possible to exempt directly from tax all electricity generated from renewable sources. Possible changes in the electricity market, and in particular the establishment of auditable "green business electricity contracts" may make this more practicable in the future. Alternatively, it may be possible to devise a scheme which provides direct incentives to renewables generators on the basis of the approximate percentage of electricity coming from renewable sources. **The Government should explore the feasibility and compliance costs involved with these options.**

126. There may be other ways in which the Government could encourage renewable energy sources. I am aware that some support for renewables exists already through the Non-Fossil Fuel Obligation. I am also aware that the Government is currently undertaking a review of its policy towards renewable energy sources. Any decisions regarding the tax treatment of renewable energy sources under a downstream carbon/energy tax would need to take into the account the outcome of that review.

Nuclear-powered generation

127. A 'downstream' tax would also treat electricity generated by nuclear power in the same way as that generated from other sources. If the tax rates were structured to reflect the carbon content of different fuels, then there might be a case for seeking some means of removing the

electricity generated by nuclear power from the scope of the tax. However, this could create significant administrative complexities given, as noted above, that it is not possible to identify at the point of supply to the final customer the generating source for the electricity consumed. I am also aware from our consultations of the arguments put forward by some that we should not favour nuclear power relative to fossil fuels for other environmental reasons, and that many existing nuclear plants are unlikely to have a significant lifespan much beyond 2010. Ultimately, the treatment of electricity generated by nuclear power under a downstream tax that reflected the carbon content of different fuels would be a matter for the Government to decide, taking into account these and other considerations.

Combined Heat and Power

128. Combined Heat and Power (CHP) can represent a very efficient method of generating electricity and heat at the point of use, reducing business costs, as well as delivering environmental benefits. I am concerned that the design of a tax should not disadvantage CHP. I suggest that, in designing any tax, the environmental benefit of CHP be balanced with the need to avoid undue administrative complexity.

129. It would be possible to treat CHP plants in the same way as electricity generators. Their input fuels could be exempt from the tax with any outputs used by the host organisation or by any other industrial/commercial undertaking subject to the tax.

130. Alternatively, as the majority of CHP plants generate electricity for use by the host organisation, it would seem logical to treat these plants as users of the primary fuels consumed by them. Fuel inputs would, therefore, be taxed (but with renewable sources exempt), and no tax would be due on electricity outputs. Tax would be refunded in relation to electricity and heat going to exempt consumers or exported to the electricity pool. On the basis of the work undertaken to date, I suggest that this approach seems the most feasible. However, the Government will wish to explore this further.

Existing mineral oil duties

131. Gas oil and fuel oil are already subject to excise duties. It could be argued that consumers of these products are already receiving price signals to encourage greater efficiency, and that additional price signals in the form of a carbon/energy tax are unnecessary. On the other hand, these signals could be undermined if, as a result of a new tax on energy products which excluded mineral oils, oil became relatively cheaper. This would point to retaining the existing differentials. Again, this is an issue which the Government will wish to consider further if it were to decide to proceed with a tax.

Treatment of energy intensive industries

132. I start from the general proposition that any tax should be applied as uniformly as possible. Artificial boundaries or thresholds will inevitably introduce distortions and inequities of one form or another.

133. I am also of the view that it is not possible to consider the case for special treatment of energy intensive industries in isolation from the issue of the size of any tax. The lower the tax, the smaller the impact on costs and the weaker the case for special treatment. And the clearer the signal of the long-term direction of policy, the lower the adjustment costs for business ought to be.

134. However, I recognise that for some energy intensive firms, even a tax set at a relatively low level could potentially form a significant part of total costs or the value of output. In addition, some energy intensive firms (though ETSU's work suggests not many) may have limited scope for further improvements in energy efficiency. Hence, I think there is a case for considering some form of special treatment for the most energy intensive users.

135. Different definitions are used to describe 'energy intensity'. The precise definitions chosen for energy, and the use of different denominators (e.g. costs or output) can give very different figures for 'energy intensity'. The Energy Intensive Users Group tends to use a threshold of energy costs comprising over 20 per cent *of total costs* as an approximate description of the 'intensive' sector; but costs of 10-20 per cent are also commonly quoted.

136. Annex C shows figures on energy costs as a percentage of total costs and the value of output for different sectors. These figures are broad averages and, as such, may conceal a wide variation of energy intensity within each sector. But they suggest that the cement, iron and steel, water and chemicals industries are among the most energy intensive.

137. There are a number of ways any special treatment for energy intensive users could be applied, including the following:

- exemptions/lower tax rates for selected industries;
- lower tax rates on energy use above a certain threshold (e.g. energy costs as a percentage of total costs or turnover);
- ceilings on total energy tax payments (defined either by the amount of tax paid or by the quantity of energy used);
- lower rates/exemptions for firms signing energy efficiency agreements;
- tax credits for firms making 'energy saving' investments, including CHP.

138. Inevitably, trade-offs exist. The better targeted the relief (e.g. by administering it at plant/process level), the more complex any scheme becomes to administer.

139. **In my view, the general aim of any relief should be to reduce the overall burden of the tax on the heaviest users,whilst retaining some incentive for all users to save energy at the margin.** It would be desirable to avoid, as far as possible, introducing distortions into the way different firms or sectors are treated. The design of the tax should also seek to minimise the costs involved in administering any relief.

140. Given these broad principles, I am not inclined towards total exemptions or different rates of tax for particular sectors or firms, which could create significant market distortions. Nor am I inclined towards absolute ceilings on total payments, which would lose the incentive to save energy and cut emissions at the margin.

141. Of the other options, I can see the attractions in having lower rates/exemptions for firms signing energy efficiency agreements with the relevant authorities (as is the case in Denmark), or offering tax relief/credits to firms making 'energy saving' investments (as is the case in the Netherlands). However, the costs of administering such schemes would need to be considered carefully, particularly if the assessments of liabilities had to be carried out on a company by company basis. (My views on voluntary and negotiated agreements in general are set out at paragraphs 36-37.)

142. A scheme involving a standard rate of tax on energy use up to a certain threshold, perhaps defined by energy costs as a percentage of total costs or output, with a lower marginal rate of tax applying above that threshold, would be consistent with the objectives set out above. To target relief, it may be preferable to provide relief only to firms in specified energy intensive sectors and to determine the extent of relief available at plant or process level. However, further work and consultation would be needed to investigate the merits and feasibility of this and the other options set out above.

How should the revenues be recycled?

143. The working assumption of the Task Force has been that the revenues would be recycled in full to business in one form or another.

144. There are many ways in which this could be done and I have received a large number of suggestions. I offer below my initial impressions of the merit of the main options. Final decisions on the use of any revenues will rest, of course, with the Chancellor of the Exchequer.

145. The main options can be grouped under two broad headings: recycling via general business taxes such as corporation tax, or employers' National Insurance Contributions (NICs), or recycling directed at schemes which have the specific aim of promoting energy efficiency or reductions in emissions.

Recycling via general business taxation

146. Recycling the revenues via general business taxation has a number of attractions. It would be simple and transparent. It would also be consistent with the Government's intention to shift the burden of taxation over time from 'goods' (e.g. labour) to 'bads' (Statement of Intent on Environmental Taxation, July 1997).

147. Many have suggested that there is scope for environmental taxes to offer a potential "double dividend" in terms of both improving the environment and allowing taxes on labour to fall, thereby offering the prospect of beneficial effects on employment. The tax package recently announced by the new German government, which involves an increase in taxes on energy and a cut in non-wage labour costs, was presented in this way. Inevitably, attempts to quantify such effects depend on the particular model of the economy used. But I recognise the possibility that, with appropriate design, a shift in the burden of taxation may be able to generate positive effects on output and employment in the economy. In thinking about the use of any revenues, the Government should consider carefully how to maximise the likelihood that such effects occur.

148. However, I am conscious that recycling revenues via general business taxation would not offer any additional incentives for improving energy efficiency and reducing greenhouse gas emissions. It would also tend to favour low energy users over energy intensive users, as the latter tend to be capital intensive and often do not have a disproportionate share of profits. In this way, recycling via general business taxation may tend to favour firms in the service sector over energy intensive firms in the manufacturing sector. This suggests that there may be a case for targeting at least some of the revenues towards schemes which aim to promote energy efficiency directly.

Recycling via schemes aimed at promoting energy efficiency and reducing emissions

149. There are a number of ways in which revenues could be recycled towards promoting energy efficiency and reducing emissions, including:

- tax relief or credits for firms making energy saving investments, including in CHP;
- some form of 'carbon trust';
- energy audits/advice, particularly for SMEs.

150. A number of responses to the consultation document identified the possible use of tax breaks for firms making energy saving investments as a further means of encouraging energy efficiency and reducing emissions. Such tax breaks could help support the development of existing fledgling technologies. There are a number of ways this could be operated, including direct rebates against any carbon/energy tax liabilities, or enhanced capital allowances to

offset against corporation tax. I note also the suggestion from the Institute of Public Policy Research (IPPR) that the tax credits could be tradeable.

151. Preferential tax treatment for investment in environmental technologies already exists in a number of OECD countries, and I am aware of the apparent success of the scheme operated in the Netherlands.

152. However, such schemes also have a number of potential drawbacks. The first is defining the investments that qualify. Ensuring the effective targeting of relief suggests the need for Government to specify a tightly defined list of energy saving investments that qualify, and for assessments to be carried out on a company by company basis. As noted above, this could be complex and costly to administer. In addition, by having a defined list of qualifying investments, it may also stifle innovation to some extent.

153. An alternative would be to channel some of the revenues into some form of 'carbon trust', as proposed by ACBE. A 'carbon trust' could stimulate the development of low carbon technologies by providing the basis for funding both collaborative research and development and the installation of demonstration projects. These are essential precursors to the deployment on a widespread basis of new techniques and technologies. I believe development of low carbon technologies will be necessary in order to meet the Government's existing climate change commitments, as well as to prepare for possible future targets beyond the Kyoto commitment period.

154. It was noted above that there may be significant opportunities for improvements in energy efficiency across the SME sector. One factor inhibiting the take up of such opportunities may be a lack of awareness of what these opportunities are. Energy audits by consultants and further advice to SMEs could help in this respect. I am aware that the Government currently offers information and advice to SMEs through its Energy Efficiency Best Practice Programme. Some of the schemes supported through the Energy Saving Trust provide subsidies for specific energy efficiency measures for SMEs. However, I believe there is scope to do a lot more.

155. Given these considerations, **I recommend that at least some of the revenues generated by any tax are channelled into schemes aimed at promoting energy efficiency and reducing greenhouse gas emissions directly – perhaps through 'carbon trust' type schemes to promote low carbon technologies and/or energy audits/advice for SMEs.**

ANNEX A: ANALYSIS OF RESPONSES TO CONSULTATION DOCUMENT

A.1 The Task Force issued a consultation document on 5 June, asking for responses by 31 July.

A.2 143 different organisations or individuals responded. A list of the respondents is attached in Table A.3. This does not include the respondents who asked for their responses to be kept confidential. These responses have been included, however, in the statistical summaries that follow.

A.3 This Annex gives a summary of these responses, based around the questions posed in the consultation document. Responses have been categorised according to the sector they come from or represent (see paragraph A.5).

Summary

A.4 The main messages of the consultation process were as follows:

- there was a wide variety of views on the lead options presented in the consultation document – trading and tax – even within individual sectors;
- respondents from almost all sectors recognised the potential role for a tax (although support was very limited amongst energy intensive users, and there were many from industry who thought it would have to apply to all sectors of the economy). On a simple numerical basis, slightly more respondents accepted that tax could play a role than thought that trading was a workable option;
- strong support for trading came largely from the energy industries and finance sector. The theoretical attraction of trading for other respondents, particularly outside the energy industries, was tempered by concerns over complexity and equity;
- there was strong support for the Task Force's assumption that any instruments should be fiscally neutral, though less consensus on the means by which this could be achieved;
- respondents tended to observe that an economy-wide carbon tax was the most efficient fiscal instrument. Some respondents saw a role only for a tax targeted at small energy users, who might not be covered by other mechanisms;
- there was no consensus on the method of trading permit distribution, but few in business favoured auctioning to existing businesses;
- there was little consensus on how long a trading scheme would take to set up;
- if there were to be a tax, almost all respondents thought that energy intensive users should receive special treatment of some kind.

Detail of responses

A.5 Responses were received from:

- trade associations and individual companies from the **energy industries** (extraction of coal, oil and gas, refining, electricity, and gas);
- **business organisations,** including trade and professional associations;
- individual companies from sectors recognised as being **energy intensive**;
- individual companies in industry or commerce whose main interest is as an **energy user**;
- individual companies in industry or commerce whose main interest is in the supply of **energy saving and other environmental technologies** or services;
- the **financial sector**;
- environmental and other **non-Government organisations** (NGOs);
- academics, **consultancies** and environmental regulators;
- **local authorities**;
- **individuals**.

A.6 There were few responses from SMEs (although they were represented by trade associations and other business organisations), and none from Trade Unions or consumer groups.

A.7 Table A.1 provides a break down of the responses by these broad sectors. Copies of individual, non-confidential, responses can be obtained from the secretariat to the Task Force, by writing to David Kemp, HM Treasury, Parliament Street, London, SW1P 3AG. Appointments to view larger numbers can also be made at the same address.

Table A.1: Respondents to consultation document

Sector	Number of respondents	as percentage
Energy industries	29	21%
Energy intensive users	15	11%
Business organisations	24	18%
General industrial or commercial energy users	19	11%
Energy saving or other environmental industries	21	13%
NGOs and other environmental organisations	8	6%
Consultancies, experts or academics	15	11%
Financial companies	5	4%
Local Authorities	3	2%
Individuals	4	3%
Total	**143**	**100%**

Paragraph A.5 discusses the definitions of these groups in more detail.

Summary of questions in consultation document

A.8 The consultation document issued by the Task Force on 6 June contained the following specific questions.

B1. Do you think trading is a workable option?

B2. What should be the coverage of a trading scheme? How far and fast might it practically be extended, especially to small firms and the commercial sector? How might one deal with competition issues between firms inside and outside the scheme?

B3. Would a trading scheme have to begin with carbon dioxide emissions or energy use? Is a scheme applying to all six greenhouse gases covered by the Kyoto Protocol a realistic prospect, and if so, how might it be implemented?

B4. How might electricity be treated in any trading scheme?

B5. How should baselines for emissions be determined for the businesses and industrial sectors covered by a scheme? How could the allocation of targets cope with new entrants and make sure that firms which have already taken action to reduce emissions are not penalised? How could any system cope with the potentially very large number of participants in a mature emissions trading scheme?

B6. Do you think it possible that a trading scheme could act as an unintentional constraint on growth?

B7. What would be the most effective and efficient way to monitor emissions and judge compliance? What sanctions would be necessary to ensure compliance?

B8. Are there any features which it is clear now that a UK trading scheme would need to incorporate so as to be compatible with international tradeable instruments?

B9. How long would a trading scheme take to establish? Would a pilot be worthwhile and if so, how long would that pilot have to last and what sectors or firms might it involve?

C1. Do you agree that tax could have a role to play? What lessons can we draw from international experience in this area?

C2. Is this potential scope of a tax appropriate in environmental terms?

C3. Would heavy users need to be given special arrangements to reduce the impact on their costs? If yes, how might this be done most appropriately, while retaining incentives to environmental improvement?

C4. Do you consider that to exempt the domestic consumer, tax would have to be applied downstream?

C5. If you consider that a downstream tax does follow from that requirement, is a further implication that tax should reflect energy rather than carbon content of fuel?

C6. If you consider that an upstream tax would be preferable in order to enhance environmental effectiveness, (a) how might an exemption for domestic and non-energy use by administered; and/or (b) how could a tax distinguish between generation source and customer?

C7. How could a tax be designed to make sure that it did not perversely discourage firms from taking action through initiatives like these to lower emissions?

D1. If you take the view that different measures may be appropriate for different parts of industry and commerce, how would this mixed approach be built up and how would the interface or overlap between measures be handled?

E1. Are there any other forms of market mechanism which could offer cost-effective greenhouse gas reductions from the industrial and commercial sectors?

Main economic instruments: tradable permit scheme or tax (B1, C1)

A.9 Questions B1 and C1 asked respondents their views on the two main options – trading and tax. On a purely numerical analysis, slightly more respondents thought that there was a role for a tax than thought that a tradeable permit system was workable. Looking at individual sectors, support for trading exceeded acceptance of a role for a tax only in the energy industries and the financial sector.

A.10 There was acceptance of the role of a tax, although with reservations about coverage and fiscal neutrality, in most sectors. However, concern over competitiveness meant there was very little support amongst energy intensive users for introduction of any new economic instrument.

A.11 Most respondents in favour of particular economic instruments expressed their views with reservations. For trading, respondents were concerned about the complexities of administering a scheme. Some doubted whether a scheme could extend to SMEs. For a tax, a large number of respondents could see the theoretical appeal of a carbon tax applying to sectors other than just business. A number expressed support for a tax conditional on it applying to all sectors, or on the fact that the revenues would be fully recycled either back to industry through tax cuts, or to fund measures that would help industry reduce greenhouse gas emissions, such as investment grants or information campaigns.

A.12 A number of respondents commented on international experience of both carbon/energy taxes and trading. Annex B contains a factual summary of the international experience of taxes and tradeable permits.

Possible coverage of trading scheme (B2)

A.13 The key difficulties over coverage of a trading scheme were recognised by most respondents: a restricted scheme could introduce concerns over equity and competition; it could also reduce the potential variability in abatement costs; and it could lead to a less liquid market for permits. Many commented that SMEs were unlikely to participate in a trading scheme, but could see that, for the greatest economic benefits, all users would have to be covered by a trading scheme.

Possible basis for tradeable permit scheme: carbon or energy (B3)

A.14 Respondents were asked whether permits should cover carbon dioxide, energy, or a number of the six greenhouse gases covered by the Kyoto Protocol. This was related to the question of how electricity should be covered by a trading scheme (B4).

A.15 There was almost no support for a system of permits based on energy. The vast majority thought that electricity generators should be required to hold permits like any other fossil fuel user. A few argued that this could lead to price rises for domestic consumers.

A.16 A majority recognised the theoretical attraction of permitting all six greenhouse gases, particularly given the likelihood that this would be the basis for the international trading system under the Kyoto Protocol. Methane and nitrogen oxides were identified as the most feasible gases to include after carbon dioxide. A significant number noted, though, that both monitoring and enforcement were harder for the non-carbon dioxide gases.

Trading scheme: possible allocation methods (B5)

A.17 There was no clear agreement on how to distribute permits. There was little support within business for auctioning of permits to *existing* players. Respondents from business tended to favour auctioning of permits that Government had held back (as in the US sulphur trading scheme) for *new* players.

A.18 A number said that the method of permit distribution needed to be fair to those who had already undertaken energy saving investments. Some in business said the only way to achieve that was through auctioning. Similarly, some NGOs and academics suggested that grandfathering permits was not in accordance with the "polluter pays" principle.

A.19 Several raised the complexity required to benchmark all firms. Those who were doubtful of the merits of trading used the complexities of permit distribution to illustrate their case.

Would permits constrain growth? (B6)

A.20 A majority agreed that a system of tradeable permits would constrain growth, although a number – particularly in the energy industries and academics – pointed out that it was the legally-binding targets agreed as part of the Kyoto Protocol that could constrain growth. Some said that if trading was the least costly way of meeting the climate change targets, then it should be favoured even if it constrained growth. A few thought that the complexities and cost of a trading system would constrain growth, particularly for SMEs. Some noted that a trading system provided opportunities for growth in some sectors, particularly in the environmental industries and finance.

A.21 Trading was also seen as potentially leading to benefits if it encouraged business to take up existing cost-effective energy saving measures.

International aspects of possible tradeable permit scheme (B8)

A.22 A large number of those who would be heavily involved in any trading system – such as the energy industries and energy intensive industries – pointed to the need for the UK's system to be compatible with all international flexibility mechanisms. This was seen as a way to lower the cost of trading to the UK economy, and to help ensure that a trading system did not provide an absolute cap on economic growth.

A.23 Some urged that the UK should wait to ensure its system would be compatible with all international mechanisms: issues of permit distribution, measurement and enforcement would all need to be transparent and compatible.

A.24 A few, however, urged that the UK should not wait, stressing the first mover benefits to those who went ahead and established schemes now.

Timescale for trading and introducing a possible pilot trading scheme (B9)

A.25 There was little agreement on how long a permit system would take to set up. The most optimistic sectors were the energy industries and the financial institutions, who thought that a scheme could be running within two years. The least optimistic were some of the environmental NGOs, who thought that trading might not be feasible before the Kyoto commitment period (2008-2012).

A.26 There was a stark dichotomy of views on a pilot trading scheme. Most thought it essential, but a few questioned its value, saying that it would be unfair to those companies involved, and would only delay full implementation. Several of those not in favour of a pilot considered that a phased implementation of a permit scheme would be more valuable than a pilot.

Treatment of heavy users (C3)

A.27 Almost all agreed that energy intensive users should receive special treatment of some kind if there were to be a tax. There was little consensus on how this might be done. Some favoured exemptions targeted at certain industrial sectors. Others suggested exemptions for IPPC-regulated sites, or for those participating in a trading scheme. A few commented that IPPC would not capture all energy intensive users, and that there were sites within IPPC that did not use energy intensively.

Possible coverage of a carbon/energy tax (C4-C6)

A.28 Despite the Task Force's remit to look only at new instruments that would apply to the industrial and commercial sector, and the Government's intention not to introduce new taxes on the domestic use of fuel and power, a consistent proportion of respondents in all sectors (between a third and a half) thought that any new tax should extend to domestic and/or transport sectors.

A.29 Respondents were also asked whether they agreed with the Task Force's analysis that the requirement to exempt the domestic sector pointed to applying any tax downstream, on final energy use by industrial and commercial customers. A majority of respondents considered that the domestic sector should not be exempted.

A.30 Some respondents thought that an upstream tax could be made to exempt the domestic sector (although without necessarily suggesting how this might be done). Those who did suggest ways to operate an upstream tax with an exemption for the domestic sector tended to suggest that the electricity supplier would be compensated on the basis of the amount of electricity sold to domestic consumers (identified through the VAT system). The complexity and potential increase in regulation of a scheme like this was generally recognised. So was the inability of guaranteeing that some domestic bills would not rise.

A.31 More respondents thought that a tax should reflect carbon content of fuels rather than being solely targeted at energy use. Some noted that, with a downstream tax, only the average value of electricity would be captured.

Treatment of CHP and renewables (C7)

A.32 There was broad agreement that an upstream carbon tax would increase the return to investments such as CHP, and would also encourage the generation and use of electricity from renewables. Alternatively, some suggested that a downstream tax could apply to the inputs to CHP, with tax being refunded on heat supplied to domestic consumers, or electricity supplied to the grid.

Analysis by sector

A.33 Table A.2 attempts to provide a broad-brush summary of the responses from each sector. This uses the sector definitions in paragraph A.5.

Table A.2: Summary of views by sector

	Trading	Tax
Energy industries	Generally keen on trading. Believe that scheme could start soon with large users and generators, and then expand. Compatibility with international trading schemes crucial. Need not constrain economic growth.	Some companies against. Others recognise potential for tax applying to those not inside any tradeable permit scheme, including small firms, domestic and transport sectors.
Energy intensive users	Doubtful of merits of trading (complex, caps growth). Trading system should extend to all business. Permits should not be auctioned. Favour IPPC and negotiated agreements as main measures to control greenhouse gas emissions.	Against, though role for carbon tax applying to domestic and transport. If apply to business, should exempt feedstocks and energy intensives or sites covered by IPPC.
Business organisations	Although complexities a concern, especially for SMEs, can see role for trading. Concerned about effects on growth. Little consensus on allocation, timing and other issues.	Little consensus: recognise potential, especially simplicity, over permits. Most would prefer carbon tax applied to domestic and transport sector, with full revenue recycling.
Industrial or commercial users	Little consensus. Although can see theoretical attraction, concerned about complexity and equity issues.	Supportive of carbon tax applying to domestic sector as well as business.
Energy saving and environmental industries	No consensus, although little real enthusiasm for permits.	Strong support for any tax applying to either business or domestic.
Environmental NGOs	Can see permits as medium to long-term solution.	Strong support. Should minimise exemptions.
Consultancies, academics and regulators	Attracted to a trading scheme limited to large users.	Strong support for universally applied carbon tax. Given Government's views on taxation of domestic sector, agree with Task Force indicative's thinking in the consultation document.
Financial sector	Strong support for widespread trading scheme as soon as possible. Large potential role for City.	No consensus.
Local Authorities	Concerned over complexities of administration.	Support.
Individuals	No consensus.	No consensus.

Paragraph A.5 discusses the definitions of these groups in more detail.

Table A.3: List of respondents (in alphabetical order)

Advisory Committee on Business and the Environment (ACBE)
AHS Emstar
Alan Ingham, University of Southampton
Alstrom
Aluminium Federation
Amerada Hess
Association for the Conservation of Energy (ACE)
Association of Electricity Producers
ATMOS Heating Systems
Australian Bureau of Agricultural and Economic Research (ABARE)
BG
BIFFA Waste Services
BOC gases
BP
Brewers & Licence Retailers Association (BLRA)
Bristol and Western Engineering Manufacturers' Association Ltd (BEMA)
British Airports Association (BAA)
British Airways
British American Tobacco (BAT)
British Cement Association
British Ceramic Association
British Electrotechnical and Allied Manufacturers' Associations (BEAMA)
British Energy
British Energy Efficiency Federation (BEEF)
British Foundry Association
British Glass
British Leather Confederation
British Nuclear Fuels (BNFL)
British Nuclear Industry Forum
British Printing Industries Federation
British Retail Consortium
British Soft Drink Association Limted
BTR
Building Energy Solutions
C Rodia - Eco services
Cambridge Econometrics
Carbon Storage Trust
CBI
Chamber of Shipping
Chartered Institute of Building Services Engineers (CIBSE)
Chemical Industries Association (CIA)
Chemical Manufacture and Refining Limited
Cheriton Technology Managment Ltd
City of Newcastle upon Tyne
Combined Heat and Power Association (CHPA)
Confederation of United Kingdom Coal Producers
Construction Industry Council
Corporation of London
Countryside Council for Wales
CSERGE
David Newbery, Department of Applied Economics, University of Cambridge
Delphi International
Dieter Helm, New College, Oxford
Eastern Group
Economic and Social Research Council (ESRC)
Edison Mission Energy
Electricity Association
Energy Intensive Users Group
Energy Saving Trust
Engineering Council
Engineering Employers' Federation (EEF)
English Nature
Enviromac
Environment Agency
Environmental Industries Commission (EIC)
Enviros
Esso UK
Food and Drink Federation
Forum for the Future
Friends of the Earth
Green Alliance
Hydro Polymers
ICI Petrochemicals
Institute of Civil Engineers
Institute of Directors (IoD)
Institute of Electrical Engineers
Institute of Professionals, Managers and Specialists (IPMS)
Institute of Public Policy Research (IPPR)
Institution of Chemical Engineers
International Petroleum Exchange (IPE)
Kemira Fertilisers
Kvaerner Energy
Lean Economy Initiative
Liverpool Chamber of Commerce and Industry
Local Government Association
Lord Ezra
Major Energy Users Council (MEUC)
Mr M J O'Carroll
National Energy Foundation
Natural Environment Research Council
National Grid
National Power
NatWest Group
Nestlé UK
Non-ferrous Alliance
Norsk Hydro Energi UK
Philip G Ramsell
Pilkington
PowerGen
Prashant Vaze
Raymond Whitaker
Resource Use Institute
Retail Motor Industry Federation
RJB Mining
Rolls Royce
Rothschilds and Sons
Royal Society for the Protection of Birds (RSPB)
Science and Technology Policy Research (SPRU)
Scotch Whisky Association
Scottish Environment Protection Agency (SEPA)
Scottish Hydro-Electric
Scottish Power
Seeboard
Selby District Council
Severn Trent
Shell UK
Socialist Environment and Resources Association (SERA)
Society of Motor Manufacturers and Traders (SMMT)
Solrec
Southern Electric
Statoil UK
Surface Engineering Association (SEA)
Swansea Energy Agency
Synpac Pharmaceuticals Limited
Talbott's Heating Limited
Target Energy Services
Thames Water
UK Offshore Operators Association (UKOOA)
UK Petroleum Industry Association (UKPIA)
UK Steel Association
United Distillers and Vintners
Warner Jenkinson Europe
Water UK
Whitby Bird & Partners Engineers
William Grant & Sons Distillers Limited
World Coal Institute
Wuppertal Institute
WWF (UK)

ANNEX B: THE INTERNATIONAL CONTEXT: KYOTO TARGETS AND EXPERIENCE OF ECONOMIC INSTRUMENTS

B.1 This Annex presents a summary of the legally-binding climate change targets accepted under the Kyoto Protocol by the principal developed countries. It also summarises the evidence presented to the Task Force on international experience of:

- trading schemes, including the US sulphur trading system;
- energy/carbon taxes, including the Dutch and Danish tax treatment of energy saving investments.

Legally binding targets under the Kyoto Protocol

B.2 Table B.1 contains details of both the legally-binding emissions targets accepted under the Kyoto Protocol by EU Member States, and details of each country's forecast emissions for 2008-2012. These targets and projections are for the basket of six greenhouse gases specified in the Kyoto Protocol. From these figures, we can calculate the policy gap: the amount that each country will have to reduce its emissions of greenhouse gases by to meet its legally-binding commitment.

B.3 In Kyoto, the European Community and its Member States signed up to an 8 per cent reduction in emissions of a basket of six greenhouse gases from 1990 levels over the period 2008 to 2012. Under the 'bubble arrangement' set out in Article 4 of the Protocol, the EU may choose to meet this target jointly. To do so, the EU must notify the UN's Climate Change Secretariat of the terms of its arrangement upon deposit of the ratification instruments. The agreement then becomes legally binding once the Protocol enters into force.

B.4 Table B.2 contains details of carbon dioxide emissions from EU Member States and some of the other developed countries who accepted targets as set out in Annex B of the Kyoto Protocol. Although carbon dioxide is the principal greenhouse gas, focusing solely on projected carbon dioxide emissions does not show the entire picture – as a comparison of these figures with the EU's targets and projections for the 6-gas basket to which the Protocol target applies demonstrates. Some countries that appear to have to make a considerable effort to achieve their target through carbon dioxide reductions may in fact choose to do so through reductions in other greenhouse gases.

Table B.1: Emissions reductions required for 6 gas basket amongst EU members

	Target in 2008–2012 as % of 1990 emissions	Projected 2010 emissions as % of 1990 emissions	Reduction required as % of target emissions
Austria	87	97·4	12
Belgium	92·5	111·8	20·8
Denmark	79	83·4	5·6
Finland	100	127·6	27·6
France	100	112·8	12·8
Germany	79	81·1	2·7
Greece	125	127·1	1·6
Ireland	113	117·6	4·1
Italy	93·5	107·5	15
Luxembourg	72	70·6	–1·9
Netherlands	94	112	19·1
Portugal	127	125·3	–1·3
Spain	115	120	4·3
Sweden	104	114·2	9·8
UK	87·5	93·2	6·6
EU (15)	92	99·8	8·5

Based on published forecasts in June 1998 at time of EU "burden-sharing" agreements.

Table B.2: Required reductions in carbon dioxide emissions, by country

	Emission commitment in 2008–2012 as a % of 1990 emissions[1]	CO_2 Projections in 2010, % of 1990 emissions under business-as-usual	CO_2 reduction required, compared to 2010 projections on a business-as-usual basis, %
EU Member States			
Austria	87	94	7·4
Belgium	93	111	16·7
Denmark	79	85	7·1
Finland	100	132	24·2
France	100	120	16·7
Germany	79	84	6·0
Greece	125	131	4·6
Ireland	113	132	14·4
Italy	94	94	0·5
Luxembourg	72	60	–20·0
Netherlands	94	121	22·3
Portugal	127	140	9·3
Spain	115	125	8·0
Sweden	104	116	10·3
EU (unweighted average) excluding Luxembourg			11·5
Non EU Countries			
Canada	94	119	21·0
Czech Republic	92	100	8·0
Japan	94	120	21·7
New Zealand	100	143	30·1
Norway	101	135	25·2
Slovakia	92	91	–1·1
Switzerland	92	101	8·9
United States	93	123	24·4

Source: US Environmental Protection Agency (EPA)

[1]All 6 greenhouse gases. Figures subject to rounding. As discussed above, although CO_2 is the principal greenhouse gas, focussing solely on projected CO_2 emissions does not show the entire picture. Some countries that appear to have to make a considerable effort to achieve their target through CO_2 reductions may choose to do so in part through reductions in other greenhouse gases.

Trading schemes: experience and lessons from existing and prospective schemes

B.5 This section discusses the historical experience of trading schemes in the US, and outlines the progress that has been made on developing tradeable permit systems to help as part of countries' climate change programmes.

Existing experience of emissions trading schemes in the US

B.6 In 1976, the US Environment Protection Agency (EPA) established an emissions trading system designed to introduce flexibility into the regulation governing the ambient standards for carbon monoxide, NOx, lead, particulates, ozone and sulphur dioxide. Use of these flexibilities was limited by ambient air quality standards, and initially participation in trading was low. However, useful experience was gained, which eventually led to the development of the US Acid Rain programme – the largest, and arguably the most successful, emissions trading scheme so far in existence.

B.7 Other trading schemes have been established. The Regional Clean Air Incentive Market (RECLAIM) trading programme in Southern California was established in 1994. Other trading examples are in the first stages of development, or at a very small scale.

US Acid Rain Programme

B.8 The sulphur trading system set up under the US Acid Rain Programme commenced in 1995 with the objective to reduce US power station sulphur dioxide emissions by more than half. There are a number of key features and results.

B.9 Key features:

- *what is traded?:* sulphur dioxide "allowances". One allowance is worth one tonne of sulphur dioxide. A fixed number of allowances are allocated to each participant for each year. Currently, allowances have been allocated for each year to 2027. Allowances may be traded, or unused allowances banked for future use;
- *industry coverage:* currently (phase 1 from 1995 to 2000) 110 large power stations. Phase 2 (commencing 2000) will expand coverage to 800 power plants across the US;
- *allowance allocation:* most allowances are "grandfathered", based on historic fuel consumption. The other allowances are auctioned: the EPA set aside approximately 3 per cent of the total annual allocation to help regulate the allowance price and reduce obstacles to new entrants;
- *institutional arrangements:* a rich set of institutional arrangements has developed including brokering firms, auction houses and futures markets;
- *compliance:* assessed through Continuous Emissions Monitoring and a central allowance tracking system. Non-compliance penalties are severe – fines of $2000 per tonne of sulphur dioxide exceedence, as well as the action necessary to comply.

B.10 Key results:

- *number of trades:* By April 1997 a cumulative total of 34 million allowances had been traded;
- *emissions reduction:* Phase 1 requires reduction in emissions of 3.6 million

tonnes of sulphur dioxide a year. Reductions have exceeded target by 3.4 million tonnes, creating allowances which are being banked for use in Phase 2;

- *costs:* compliance costs estimated to have been reduced by one third to one half, but estimates are wide ranging. The US EPA calculated the cost savings from the Acid Rain Programme as the costs of achieving the regulatory limits without trading minus the costs of doing so with trading. They calculated that, "as of 1994, the estimated cost of the program would be $2-2.5 billion per year by 2010. This cost is half what a command and control regulatory program would cost."

RECLAIM

B.11 RECLAIM was set up to improve air quality in Southern California and reduce costs of achieving federal standards for 2010. Total limits of NOx and SOx have been set, and participating facilities receive emission allowances valid for 1 year based on peak fuel consumption over a baseline period.

B.12 Currently RECLAIM covers facilities which account for approximately 65 per cent of NOx (390 facilities) and 85 per cent of SOx (41 facilities) from stationary sources. The trading market has steadily developed from 8.6 million credits auctioned in August 1995 with 32 facilities participating. The US EPA calculate that the scheme will lower the costs of achieving a given standard of air pollution by 40 per cent compared with regulation (or approximately $155 million a year).

Other trading schemes

B.13 A system of tradeable permits was set up for the Fox River in the US. It was designed to achieve US national water standards, introduced under the 1972 Clean Water Act, at a lower cost than regulation. Although simulations predicted cost savings of $6.8m, these were not realised in practice, due to concerns over the legality of rights being traded, a number of restrictions on trade, and a complex administration system.

B.14 The US is the firmest supporter of emissions trading within the United Nations Framework Convention on Climate Change (UNFCCC) process. Their negotiators within the UNFCCC have argued that the US will set up a domestic carbon trading programme, and they point to their sulphur trading programme as a good example of how emissions trading can deliver environment benefit at lower cost to other measures such as regulation. US officials have also indicated in speeches and in evidence to Congress that they will set up a domestic programme. The EPA has indicated that it is working on the design of a carbon dioxide trading programme. If the Kyoto Protocol is ratified, the US are very likely to want to use a trading system.

B.15 A "greenhouse gas emission reduction pilot" has been established in Canada, driven mainly by the provincial government of British Columbia. The pilot allows emission reduction credits to be created through specific projects aimed at demonstrating a real and measurable reduction in emissions compared to business as usual. It is a partial form of trading based around crediting for individual projects. Government partners in the pilot scheme have agreed to recognise emission reductions from trades registered under the pilot as progress towards possible compliance obligations in the context of any future greenhouse gas trading regime, but details are unclear at present how this could be done.

B.16 The Norwegian Parliament has recommended that Norway use carbon emission trading as a means of achieving its emissions target. In June, the Parliament's majority instructed the minority Government to introduce a domestic quota system. Initially it seems that the quota system could apply to the 40 per cent of Norway's industrial emissions not covered by the

current carbon dioxide tax system. Other greenhouse gases could also be included. However the Commission investigating this scheme will also look at the sectors currently subject to carbon dioxide taxation to see how they might be included.

B.17 In March 1998, the New South Wales Environment Protection authority issued a report of a working group which outlined how a tradeable emissions market for electricity retailers in the State would work. It concluded that such a scheme was workable, but recommended that it not be implemented until the national climate change programme had been worked out. The New Zealand Ministry for the Environment issued a technical working paper in August 1998 on how a trading scheme might operate.

B.18 Other European countries have indicated that carbon trading is an option under active consideration. Countries such as Finland, the Netherlands, Denmark and France have shown strong interest in exploring this option, although they are not so far advanced as the UK in discussing proposals with outside groups.

Energy taxes in other European countries

B.19 Since 1990, six European countries have introduced explicit taxes on the carbon or energy content of fuels. These are Norway, Sweden, Finland, Denmark, Austria and the Netherlands. In addition, Italy has recently announced powers to enable it to phase in taxes on energy over a period of years. The new coalition Government in Germany have proposed increases in the excise duties on gas, oil, road fuels and electricity.

B.20 At present, only taxation of mineral oils is covered by European legislation. In March 1997, the European Commission published a proposal for a Council Directive which would restructure the Community framework for the taxation of energy products. The proposed Directive is subject to unanimity. In broad terms, the proposal would extend the scope of EU minimum duty rates and structure provisions to apply to all energy products – including coal, gas and electricity – and not just mineral oils, which are currently covered. It would also increase the existing minimum duty rates on mineral oils. However, the Task Force has noted the Government's views on the draft Energy Products Directive, as set out in the explanatory memoranda of May and December 1997.

B.21 The Task Force has considered the experience of the six European countries who operate taxes on energy. International comparisons, however, are not generally straightforward. Energy taxes must be seen in the wider context of other environmental policy measures, which will vary between countries. More importantly, the pattern of business energy use and electricity generation varies considerably between countries. In summary:

- of the six countries that tax energy, three countries operate carbon taxes, two reflect both carbon and energy, and one country charges an energy tax;
- all six countries tax electricity downstream, at the point of consumption;
- all countries now grant special treatment to some parts of industry. These have been justified by concerns over sectoral competitiveness. The special treatment has usually taken one of the following forms:
  - reduced rates of tax;
  - tax exemptions for certain sectors or industries;
  - caps on the total amount of tax paid, usually in proportion to total sales or costs.
- CHP and renewable sources of electricity receive special treatment in some Scandinavian countries;

- the Netherlands and Denmark reduced other taxes alongside the introduction of energy taxes to ensure that the average tax burden on business remained broadly unchanged. Austria earmarks around 20 per cent of revenues for energy saving measures and public transport, but the bulk goes to the general budget. Finland and Norway use the revenues as part of the general budget;

- few studies have looked at the historical effectiveness of the taxes at reducing greenhouse gas emissions. A study by the Swedish Environmental Protection Agency estimated that the introduction of a carbon tax reduced emissions by 2 per cent, but suggested that the lower rates and exemptions for parts of industry meant that reductions were not being achieved in the most cost-effective way. A more recent study by the Swedish Green Tax Commission estimated that doubling the current tax rates would reduce emissions by between 0.2 per cent to 1.6 per cent;

- a study of Norwegian carbon dioxide emissions concluded that the carbon dioxide tax had brought about shifts in the carbon-intensity of energy use. Shifts in the direct business use of energy (largely from electricity to oil) were estimated to have reduced carbon emissions by 0.1–0.3 per cent of the Norwegian total, before the effects on overall energy consumption were considered. The carbon intensity of transport use of energy declined by 3 per cent over a similar time period;

- in Denmark, certain businesses (mostly those in energy intensive sectors) can negotiate a reduced carbon tax rate if they undertake to implement energy saving measures. In the Netherlands, tax credits and free depreciation are available to companies investing in energy saving or innovative environmental technologies.

B.22 Table B.3 gives a summary of the tax rates applied in these countries. Table B.4 gives further details by country.

Table B.3: Effective tax rates on energy products in other countries

country	tax [1, 2]	heavy fuel oil £/1000 kg	natural gas pence/m³	coal £/1000 kg	electricity pence per kWh
Sweden	carbon	44	3·1	34·6	0
	energy	57·2	1·8	23·5	11·5
Finland	carbon	37·6	1·2	28·9	4·1
Netherlands	carbon/energy	0	21·3[4]	0	3
	energy	10·3	10·5[4]	7·4	0
Denmark	carbon	30·1	2·1	22·8	10
Austria	energy	26·2	3·5	0	0·6
Norway	carbon	34·9	n/a[3]	34·2	0

[1] Tax rates from 1997 except Finland and Denmark (1998).

[2] Tax rates are highest applicable. Some reduced rates are levied in certain conditions.

[3] Tax applies to gas used on continental shelf activities.

[4] Pounds per tonnes of LPG.

Source: Task Force calculations.

Table B.4: Details of energy tax regimes internationally

Sweden: Fossil fuel use in Sweden is affected by a carbon dioxide tax and an energy tax. A sulphur tax applies where relevant. Separate taxes are charged on the consumption and production of electricity.

Special treatment:

- fuels used in generation are exempt from the carbon dioxide tax;
- manufacturing industry and the horticulture sector are exempt from the energy and electricity tax, and pay a reduced rate of carbon dioxide tax, up to a total tax payment of 0.8 per cent of turnover;
- fuels used in CHP plants are liable to 50 per cent of the standard rate of the carbon dioxide and energy tax;
- wind power generators are exempt from the electricity tax. Lower rates apply to energy industries, heating and water supply, northern municipalities, manufacturing and horticulture.

Revenues from all three taxes go to the central budget. As of 1 April 1998, the general carbon dioxide tax rate is SKr 0.37 per kg of CO2 (£27 per tonne of CO2). Revenues from energy and carbon taxes from all sectors comprised around 3 per cent of GDP.

Finland: Finland was the first European country to introduce an explicit carbon tax, which it did in 1990. In 1997, Finland reformed the tax systems, and now has simple excise duties, a carbon tax, and a downstream electricity tax.

Special treatment:

- **carbon tax:** applies to all fossil fuels, except that natural gas has a permanent 50 per cent reduction in the rate of tax. Until 1997, there were no exemptions for industry (except fuels used as intermediate inputs for other energy products). Since 1997, special treatment has been available for energy intensive industries;
- e**lectricity:** industrial users face lower rates than domestic and service sector users. Generators using wood, and small renewable and CHP sources, receive a subsidy equivalent to the rebated tax;
- **CHP:** separate rules apply for CHP, which is an important source of energy in Finland. Fuel used for heat production is taxable, and that used for generation is exempt. Experience suggests that this is a complicated system, especially where a number of fuels are used in CHP plants.

Revenues: in 1996, taxes on energy and carbon from all sectors raised 16.2 billion FMK.

Austria: an energy tax has applied to gas and electricity since 1996. (Oils are taxed under the EU's harmonised excise regime).

Special treatment:

- the total tax burden for energy-intensive firms equal is capped at 0.35 per cent of the net value of production for manufacturing industry;
- the energy tax does not apply to small autogenerators, or gas used in generation.

Revenues: in 1996, revenues were 3 billion Sch (and forecast to be 7 billion Sch for 1997). This is partly earmarked for energy-saving measures (690 million Sch in 1997) and public transport (730 million Sch in 1997).

Denmark: in 1993 Denmark introduced a tax on business use of energy (the carbon dioxide tax) to complement taxes which impact principally on domestic use of energy (energy taxes). In 1996, this tax was reformed, and an sulphur dioxide tax introduced, to be phased in between 1996 and 2000. A tax is levied downstream on electricity consumption.

Special treatment:

- **carbon dioxide tax:** different rates apply to energy used in space heating, light processes, and heavy processes. Heavy processes (specified in legislation) are liable for the lowest rate;
- **negotiated agreements with energy intensive businesses:** businesses which undertake heavy processes, and those undertaking light processes with high energy tax burdens, can secure a three year agreement for a reduced carbon dioxide tax rate if they undertake to implement energy saving measures;

- **electricity tax:** industry is either fully or partially reimbursed. Electricity generated in small plants (less than 150 kW) and from renewable sources is exempt;
- **coal** used in generation is exempt from energy and carbon dioxide taxes on coal.

Revenues from the business and domestic sector comprised 1.4 per cent of GDP in 1996. Revenues are recycled to business through offsetting measures such as a reduction in employers' social security contributions, investment grants for energy saving measures, and earmarking of funds towards small and medium sized enterprises.

The Netherlands operates a carbon dioxide/energy tax on small energy users (introduced in 1996), and a fuel tax. The carbon dioxide/energy tax applies to all households and almost all businesses. Users are granted a tax-free allowance, and tax rates are zero above certain fixed levels of energy consumption.

Special treatment:

- the greenhouse horticulture sector is subject to a zero rate on natural gas taxation, but receives no special treatment on electricity. This sector is also required to improve energy efficiency by 50 per cent over the 1980-2000 period;
- tax exemptions also exist for environmentally-friendly technology such as:
  - heat supplied via district heating;
  - gas used in electricity generation;
  - generation of electricity using renewable sources.

Tax incentives for investment:

- companies that invest in certain energy saving measures can receive corporation tax credits of 40 per cent of the value of the investment. In addition, companies may also be able to benefit from free depreciation allowances if they invest in specified innovative environmental technologies. This can include energy saving equipment.

Revenues from the carbon dioxide/energy tax were estimated at 940 million HFl in 1996. These are recycled so that average energy users do not face an increase in total tax payments.

Norway applies a carbon tax on consumption of fossil fuels, excise duties on all energy use, and a sulphur tax on mineral oils. Revenues go into the general budget.

Special treatment:

- energy intensive industries pay a reduced rate or are exempt from the carbon tax.

ANNEX C: BUSINESS ENERGY COSTS, OUTPUT AND EMPLOYMENT BY SECTOR

C.1 The Task Force has considered the effect of any economic instrument upon different sectors of industry and services. As part of that consideration, data was presented to the Task Force on energy use and expenditure, broken down by sector. This data, along with selected economic and environmental data series, is presented below.

C.2 The approach of combining economic and environmental data series is similar to that pursued in the UK's environmental accounts[1]. However, the data presented here is from more recent years than that previously published as part of the environmental accounts.

C.3 It must be stressed that it is not possible to determine the effect of an economic instrument on different sectors of business by examining data on energy expenditure alone. There are a number of other factors that will be relevant:

- Annex E contains some analysis of the opportunities for energy saving available in different industries;
- Annex F contains estimates of the responsiveness of energy use to changes in energy prices;
- Annex G contains data on the relative energy prices faced by industry in other countries.

C.4 Table C.1 presents a breakdown of business energy use by individual fuel, comparing that with other sectors. It shows that business accounted for almost 40 per cent of final energy use in 1996, and gives an indication of the relative importance of each fuel to different sectors.

C.5 Tables C.2 and C.3 contain more disaggregated data on energy use and costs within individual sectors of industry and services.

C.6 These tables contain, alongside other series, data on direct use of energy. This means that the energy consumption (and costs) attributed to an industry does not include the energy consumed in producing any intermediate goods used by that industry[2]. They also exclude fuels used as chemical feedstocks or for transport purposes.

C.7 Table C.3 presents two methods of estimating the energy intensity of different sectors of business. This has been done by looking at expenditure on energy as a percentage of:

- total production costs (raw materials, services and labour costs);
- gross output.

These terms are explained further below. There is no definitive way of calculating energy intensity. Table C.3 presents one method; other methods exist, but different calculations typically identify a common set of energy intensive sectors.

C.8 There are a number of other factors that must be considered when examining the figures in Table C.3:

i. a variety of sources have been used to consider energy consumption and expenditure across industries, and the quality of the data is not perfect in all cases. The data sources are discussed further below;

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1 UK Environmental Accounts 1998 (Office for National Statistics). Available from The Stationery Office.

2 The alternative "lifecycle analysis" approach allocates all the energy embodied in a product to its final production. This is used in estimating the true energy input to a product, but will not tell us how much energy each of the industries consumed in contributing to that product. See the UK Environmental Accounts for more detail on this.

ii. the data presented here is generally at the level of 2 digit SIC codes, but is further disaggregated for a few of the 2 digit energy intensive sectors. There are two general issues to consider when disaggregating:

- the greater the disaggregation attempted, the greater the uncertainties in the data;
- a focus on more narrowly defined sectors would have shown a greater variation in the importance of energy costs.

iii. there will also be considerable variation across firms *within* these identified industry groups. It is possible that for individual firms within a sector, energy expenditure may constitute a higher (or lower) proportion of production costs or output than the broad sectoral averages presented here.

Data sources and limitations

C.9 The figures in this annex are for 1996, and cover manufacturing and services, disaggregated by Standard Industrial Classification 1992 (SIC92). The energy supply and extraction industries are not included, nor is the transport industry.

C.10 Energy consumption data is not available at a disaggregated level, and some degree of estimation has been necessary. Any limitations on the reliability of the energy consumption data will also be reflected in the expenditure and carbon dioxide data. (Information on energy consumption and expenditure at a more aggregated level is given in DUKES[3]).

Estimated Energy Consumption

C.11 Estimates of energy consumption are based on final consumption as defined in DUKES. These figures exclude the use of fuels for the production of secondary fuels and non-energy purposes. The consumption of electricity from autogeneration is included: its inputs are not.

C.12 In general the estimates in Tables 1.6 and 1.9 of the 1998 DUKES are assumed to be accurate, and all estimates in the tables have been made consistent with them (except those for gas oil, which use Table 4.10). The mineral products and plastics and rubber sectors have been further sub-divided using information from ETSU, grossed up to agree with the DUKES totals for 1996.

C.13 This breakdown has been further subdivided using the Purchases Inquiries. There are a number of issues regarding the quality of the Purchases Inquiry data, particularly that the Purchases Inquiry covers only a selection of industries in each year, so several years' data have to be used to get complete coverage. Where a sector is actually covered by the 1996 Inquiry, information from it is used directly, converted to volume terms using prices or average values obtained from the 1998 DUKES. Where it is not covered by the 1996 Inquiry, the information from the earlier years is used (converted to volume terms using prices for that year), and then adjusted to 1996 by taking the change in the Index of Production for the sector between 1994 or 1995 and 1996. This assumes that energy consumption per unit of output in the sector concerned remains constant over the period. For a few sectors the latest Purchases Inquiry data relates to 1989, the year of the last full Purchases Inquiry.

C.14 For services, DUKES figures for electricity have been disaggregated into sub-sectors using Building Research Establishment (BRE) figures for 1994. The fossil fuels figures were disaggregated using Digest Tables 4.10 and 5.6. In order to split the distributive trades into wholesale and retail, the figures were split in proportion to the BRE figures.

3 Digest of UK Energy Statistics 1998, DTI, available from The Stationery Office.

Estimated expenditure on energy

C.15 Estimates of total expenditure on energy were derived by multiplying the estimated volume data by price data from Table 8.9 in DUKES. For the production industries covering SIC 13-45 the average prices were used. For the services sector, prices for small users were used for SIC 50-96 (except for SIC 50-52, 64 for electricity and SIC 55, 90-93 for gas, where the median price was used).

C.16 It is likely that there will be some *overstatement* of expenditure in those sectors which are energy intensive, as these larger users will be able to negotiate contracts at lower prices than average consumers. For those sectors with smaller users, expenditure is likely to be understated as the average prices will give more weight to the prices paid by large users. These differences are more important for some fuels, notably gas.

Total production costs

C.17 Total production costs are defined as total purchases of goods and services plus total employment costs. For industrial sectors SIC 13–45, these data were taken from the ONS's 1996 Annual Business Inquiry (ABI) (formerly the Annual Census of Production (ACOP)). For the service sector, data were taken from Annual Distributive and Service Trades inquiries for 1996, but some estimation was required for the following sectors: communication SIC64; financial services SIC65–70; education SIC80, Health SIC85, and public administration (SIC 75). Goods bought for resale have been included within total production costs (they are excluded from gross output). In the service sector, wholesaling and retailing sectors, goods for resale can form up to 85 per cent of total purchases.

Estimated carbon dioxide emissions

C.18 To estimate carbon dioxide emissions, energy consumption estimates have been combined with average emission factors consistent with those used in the National Atmospheric Emissions Inventory for 1996 produced by NETCEN, the National Environmental Technology Centre of AEA Technology plc. Emissions from electricity are based on average fuel use across all generators. It should be noted that the method does not take into account emissions of carbon dioxide from other uses – it only accounts for emissions from fossil fuel combustion (excluding transport) – and that the use of fuels for non-energy purposes may well lead to emissions of carbon dioxide or other gases.

Gross output

C.19 The figures for gross output are from the ONS's 1996 Input Output balances, and are on the 1979 European System of Accounts basis. Further information on these figures can be found in *Input-Output Methodological Guide* published by The Stationery Office. The gross output of an industry is the aggregate value of goods and services, together with the work in progress produced by the industry. It is equal to the value of the industry's sales plus any increase in the value of its stocks of finished products and work in progress (output does not include stock appreciation). The outputs of the distribution and service trades industries are measured on a gross margin basis (i.e. output includes only the margin on sales of goods for resale without further processing, not the sale price of those goods).

Employee Jobs

C.20 Figures for employee jobs cover Great Britain only. These figures are from the ONS's Annual Employment Survey for 1996 and the figures represent the position as at September 1996. Employee jobs exclude the self employed (see "Labour Market Trends", July 1998, ONS).

Table C.1: Energy consumption by sector, 1996, thousand tonnes of oil equivalent

	Industry	Transport	Domestic	Services	Agriculture	Total
Coal	2,488	0	2,085	416	9	**4,998**
Other solid fuels[1]	3,892	0	623	40	0	**4,555**
Gas[2]	15,667	1	32,322	10,191	122	**58,303**
Petroleum	6,702	51,606	3,601	3,782	895	**66,586**
Electricity	8,869	638	9,246	7,204	329	**26,286**
Renewables[3]	536	0	241	109	72	**958**
Total	**38,154**	**52,245**	**48,118**	**21,742**	**1,427**	**161,686**

[1] Includes coke and breeze and other non-renewable solid fuels.

[2] Includes natural gas, coke oven gas and colliery methane.

[3] Includes solid and gaseous renewables, and solar, geothermal heat.

Table C.2: Economic and environmental data by sector

SIC 92 codes	Sector name	Gross Output[2] (£million)	% of total	Estimated Employee Jobs[1] (thousands)	% of total	Energy Consumption[3] (thousand toe)	% of total	Est. CO_2 emissions[4] (thousand tonnes of carbon)	% of total
13-14	MINING & QUARRYING	3,566	0·3	32.4	0·2	580	1·0	588	1·0
15	FOOD PRODUCTS & BEVERAGES	50,704	4·3	428·8	2·0	4,376	7·4	3,964	6·7
16	TOBACCO PRODUCTS	8,655	0·7	6·4	0·0	60	0·1	50	0·1
17	TEXTILES	10,514	0·9	180·8	0·9	904	1·5	837	1·4
18	WEARING APPAREL & FUR	5,757	0·5	140·7	0·7	178	0·3	164	0·3
19	LEATHER & ARTICLES; FOOTWEAR	2,035	0·2	37·6	0·2	69	0·1	67	0·1
20	WOOD & PRODUCTS EX FURNITURE	4,928	0·4	82·9	0·4	465	0·8	470	0·8
21	PAPER & PAPER PRODUCTS	3,997	0·3	121·8	0·6	1,923	3·2	1,853	3·1
22	PRINTING, PUBLISHING & REPRODUCTION	35,393	3·0	347·6	1·7	680	1·1	738	1·3
24	CHEMICALS & CHEMICAL PRODUCTS	42,074	3·5	246·6	1·2	7,196	12·1	6,585	11·2
	241 Basic chemicals	15,283	1·3	73·7	0·4	5,087	8·6	4,595	7·8
	2411-14 Basic chemicals ex fertilisers	8,901	0·7	46·6	0·2	4,419	7·5	3,947	6·7
	2415 Fertilisers & nitrogenous compounds	707	0·1	2·4	0·0	152	0·3	107	0·2
	2416-17 Plastics in primary form, synthetic rubber	5,675	0·5	24·6	0·1	515	0·9	541	0·9
	242 Pesticides & other agro-chemical products	1,427	0·1	4·1	0·0	144	0·2	129	0·2
	243 Paints, varnishes, printing inks, mastics	2,990	0·3	24·0	0·1	165	0·3	166	0·3
	244 Pharmaceuticals, medicinal chemicals etc.	10,464	0·9	58·9	0·3	687	1·2	649	1·1
	245 Soap, cleaning preps, perfumes, costmetics	5,923	0·5	41·9	0·2	241	0·4	228	0·4
	246 Other chemical products nes	4,922	0·4	40·8	0·2	576	1·0	502	0·9
	247 Man-made fibres	1,065	0·1	3·2	0·0	296	0·5	315	0·5
25	RUBBER & PLASTIC PRODUCTS	17,771	1·5	226·5	1·1	2,342	4·0	2,373	4·0
	251 Rubber products	3,693	0·3	46·5	0·2	455	0·8	460	0·8
	252 Plastic products	14,078	1·2	180·0	0·9	1,886	3·2	1,914	3·3
26	OTHER NON-METALLIC PRODUCTS	10,973	0·9	143·0	0·7	2,597	4·4	2,455	4·2
	261 Glass & glass products	2,690	0·2	36·4	0·2	517	0·9	464	0·8
262 & 3	Ceramic products	2,111	0·2	45·6	0·2	322	0·5	274	0·5
	264 Bricks	670	0·1	11·7	0·1	367	0·6	280	0·5
	265 Cement, lime & Plaster	955	0·1	4·9	0·0	1,127	1·9	1,155	2·0
	266-8 Articles of concrete etc.	4,547	0·4	44·4	0·2	264	0·4	282	0·5
27	BASIC METALS	18,258	1·5	134·9	0·6	9,170	15·5	9,496	16·1
	271-3 Basic iron & steel & first processing	10,135	0·9	67·2	0·3	7,389	12·5	7,748	13·2
	274 Basic precious & non-ferrous metals	5,856	0·5	28·2	0·1	1,149	1·9	1,107	1·9
	275 Casting of metals	2,267	0·2	39·5	0·2	633	1·1	641	1·1
28	FABRICATED METAL PRODS EX MACHINERY	23,453	2·0	437·5	2·1	673	1·1	664	1·1
29	MACHINERY & EQUIPMENT NES	31,428	2·6	393·2	1·9	1,274	2·1	1,325	2·3
30	OFFICE, ACCOUNTING & COMP. MACHINERY	12,559	1·1	48·1	0·2	73	0·1	95	0·2
31	ELECTRICAL MACHINERY &APPARATUS	12,140	1·0	178·8	0·9	397	0·7	458	0·8
32	RADIO, TV, COMMUNICATION EQUIPMENT	14,205	1·2	130·2	0·6	353	0·6	447	0·8
33	MEDICAL PRECISION INSTRUMENTS ETC	9,869	0·8	156·0	0·7	125	0·2	143	0·2
34	MOTOR VEHICLES, TRAILERS ETC	31,970	2·7	222·8	1·1	1,053	1·8	1,024	1·7
35	OTHER TRANSPORT EQUIPMENT	14,181	1·2	155·1	0·7	663	1·1	706	1·2
36	FURNITURE, MANUFACTURING NES	9,973	0·8	189·7	0·9	716	1·2	637	1·1
41	COLLECTION, PURIFICATION & DISTRIBUTION OF WATER	3,835	0·3	43·6	0·2	586	1·0	822	1·4
45	CONSTRUCTION	90,178	7·6	858·2	4·1	1,163	2·0	1,027	1·7
	INDUSTRY	**468,416**	39·5	**4,943·2**	23·6	**37,617**	63·5	**36,989**	62·8
50-51	WHOLESALE TRADE	94,955	8·0	1,547·8	7·4	1,401	2·4	2,019	3·4
52	RETAIL TRADE	55,621	4·7	2,198·4	10·5	2,671	4·5	3,588	6·1
55	HOTELS & RESTAURANTS	32,761	2·8	1,248·2	6·0	1,967	3·3	1,660	2·8
64	POST AND TELECOMMUNICATIONS	33,509	2·8	441·0	2·1	937	1·6	923	1·6
65-74	OFFICES	299,498	25·2	3,930·8	18·8	2,068	3·5	2,521	4·3
75	PUBLIC ADMINISTRATION	80,038	6·7	1,361·1	6·5	3,117	5·3	2,679	4·6
80	EDUCATION	51,102	4·3	1,765·4	8·4	3,028	5·1	2,922	5·0
85	HEALTH	20,022	1·7	2,432·7	11·6	3,133	5·3	2,817	4·8
90-93	OTHER SERVICES	51,166	4·3	1,053·1	5·0	3,313	5·6	2,742	4·7
	SERVICES	**718,672**	60·5	**15,978·5**	76·4	**21,633**	36·5	**21,873**	37·2
	TOTAL	**1,187,088**	100·0	**20,921·7**	100·0	**59,250**	100·0	**58,862**	100·0

1 Source: Annual Employment Survey 1996, ONS, Covers Great Britain as at September 1996.
2 Source: 1996 Input Output tables, ONS 1998 Blue Book, ESA79 basis.
3 Excludes transport fuels & non-energy use. Source: DTI estimates, 1996 based on Digestof UKEnergy Statistics 1998 data, Purchases Inquiry and ETSU data.
4 Source: DTI estimates based on DTIestimates of final energy consumption and estimated emissions factors from National Atmospheric Emissions Inventory 1996. Emissions are from combustion of fossil fuels for energy uses, including electricity.

Table C.3: Estimated energy intensity by sector

SIC 92 codes	Sector name	Gross Output [1] (£million)	% of total	Estimated expenditure on energy [2] (£million)	Total production costs [3] (£million)	Estimated expenditure on energy as percentage of total production costs [4] %	Estimated expenditure on energy as percentage of gross output [4] %
13-14	MINING & QUARRYING	3,566	0·3	124	2,673	4·6	3·5
15	FOOD PRODUCTS & BEVERAGES	50,704	4·3	689	53,498	1·3	1·4
16	TOBACCO PRODUCTS	8,655	0·7	8	1,984	0·4	0·1
17	TEXTILES	10,514	0·9	145	9,354	1·5	1·4
18	WEARING APPAREL & FUR	5,757	0·5	30	5,028	0·6	0·5
19	LEATHER & ARTICLES; FOOTWEAR	2,035	0·2	12	1,896	0·6	0·6
20	WOOD & PRODUCTS EX FURNITURE	4,928	0·4	102	4,877	2·1	2·1
21	PAPER & PAPER PRODUCTS	3,997	0·3	330	10,978	3·0	8·3
22	PRINTING, PUBLISHING & REPRODUCTION	35,393	3·0	158	21,512	0·7	0·4
24	CHEMICALS & CHEMICAL PRODUCTS	42,074	3·5	1,127	35,873	3·1	2·7
	241 Basic chemicals	15,283	1·3	776	14,000	5·5	5·1
	2411-14 Basic chemicals ex fertilisers	8,901	0·7	661	8,081	8·2	7·4
	2415 Fertilisers & nitrogenous compounds	707	0·1	14	690	2·0	2·0
	2416-17 Plastics in primary form, synthetic rubber	5,675	0·5	101	5,228	1·9	1·8
	242 Pesticides & other agro-chemical products	1,427	0·1	23	1,363	1·7	1·6
	243 Paints, varnishes, printing inks, mastics	2,990	0·3	32	2,806	1·2	1·1
	244 Pharmaceuticals, medicinal chemicals etc.	10,464	0·9	119	7,011	1·7	1·1
	245 Soap, cleaning preps, perfumes, costmetics	5,923	0·5	43	5,579	0·8	0·7
	246 Other chemical products nes	4,922	0·4	79	4,307	1·8	1·6
	247 Man-made fibres	1,065	0·1	55	806	6·8	5·2
25	RUBBER & PLASTIC PRODUCTS	17,771	1·5	409	15,910	2·6	2·3
	251 Rubber products	3,693	0·3	84	3,606	2·3	2·3
	252 Plastic products	14,078	1·2	325	12,303	2·6	2·3
26	OTHER NON-METALLIC MINERAL PRODUCTS	10,973	0·9	348	8,760	4·0	3·2
	261 Glass & glass products	2,690	0·2	81	2,171	3·7	3·0
262 & 3	Ceramic products	2,111	0·2	48	1,756	2·7	2·3
	264 Bricks	670	0·1	41	389	10·6	6·2
	265 Cement, lime & Plaster	955	0·1	119	633	18·8	12·4
	266-8 Articles of concrete etc.	4,547	0·4	60	3,812	1·6	1·3
27	BASIC METALS	18,258	1·5	1,602	16,607	9·6	8·8
	271-3 Bacic iron & steel & first processing	10,135	0·9	1,280	8,812	14·5	12·6
	274 Basic precious & non-ferrous metals	5,856	0·5	203	5,821	3·5	3·5
	275 Casting of metals	2,267	0·2	119	1,974	6·0	5·2
28	FABRICATED METAL PRODS EX MACHINERY	23,453	2·0	134	20,608	0·7	0·6
29	MACHINERY & EQUIPMENT NES	31,428	2·6	275	29,259	0·9	0·9
30	OFFICE, ACCOUNTING& COMP. MACHINERY	12,559	1·1	22	12,228	0·2	0·2
31	ELECTRICAL MACHINERY &APPARATUS	12,140	1·0	100	11,640	0·9	0·8
32	RADIO, TV, COMMUNICATION EQUIPMENT	14,205	1·2	105	13,324	0·8	0·7
33	MEDICAL PRECISION INSTRUMENTS ETC	9,869	0·8	32	8,919	0·4	0·3
34	MOTOR VEHICLES, TRAILERS ETC	31,970	2·7	194	31,847	0·6	0·6
35	OTHER TRANSPORT EQUIPMENT	14,181	1·2	146	13,015	1·1	1·0
36	FURNITURE, MANUFACTURING NES	9,973	0·8	119	10,384	1·1	1·2
41	COLLECTION, PURIFICATION & DISTRIBUTION OF WATER	3,835	0·3	217	1,641	13·2	6·7
45	CONSTRUCTION	90,178	7·6	212	71,130	0·3	0·2
	INDUSTRY	**468,416**	39·5	**6,641**	**412,936**	1·6	1·4
50-51	WHOLESALE TRADE	94,955	8·0	709	418,570	0·2	0·7
52	RETAIL TRADE	55,621	4·7	1,220	158,820	0·8	2·2
55	HOTELS & RESTAURANTS	32,761	2·8	444	29,129	1·5	1·4
64	POST AND TELECOMMUNICATIONS	33,509	2·8	289	27,158	1·1	0·9
65-74	OFFICES	299,498	25·2	824	206,147	0·4	0·3
75	PUBLIC ADMINISTRATION	80,038	6·7	705	75,397	0·9	0·9
80	EDUCATION	51,102	4·3	855	42,171	2·0	1·7
85	HEALTH	20,022	1·7	740	80,617	0·9	3·7
90-93	OTHER SERVICES	51,166	4·3	710	35,616	2·0	1·4
	SERVICES	**718,672**	60·5	**6,497**	**1,073,625**	0·6	0·9
	TOTAL	**1,187,088**	100·0	**13,139**	1,486,561	0·9	1·1

1 Source: 1996 Input Output tables, ONS 1998 Blue Book, ESA79 basis.

2 Excludes transport fuels & non-energy use. Source: DTI estimates for 1996, based on DTI estimates of energy consumption and DTI energy prices data.

3 Source: Production industry figures from 1996 Annual Business inquiry, ONS. Services sector figures from Annual Distributive and Service Trades inquiries, 1996 with some DTI estimation.

4 It must be noted when looking at these ratios that there are large variations within these sectors as well as on an individual company basis.

ANNEX D: THE INTEGRATED POLLUTION PREVENTION AND CONTROL DIRECTIVE (IPPC)

D.1 This Annex discusses the purpose and workings of IPPC, and the role it might have on minimising wasted energy in industry and reducing carbon dioxide emissions.

Purpose of IPPC Directive

D.2 The aim of the IPPC Directive is to achieve a high standard of protection for the environment as a whole through the regulation of specified industrial installations. The Directive is not targeted at any one environmental impact – such as climate change – but requires a balanced and integrated consideration of all environmental impacts from the relevant industrial installations, including emissions to air, water and land, energy efficiency, odour, and noise.

Scope of IPPC

D.3 In the UK, the Directive may eventually apply to some 6,000 industrial installations. Coverage is determined by a list of installation types contained in an Annex to the Directive. Table D.1 gives details of the coverage of IPPC across different industrial sectors. It gives estimates for the number of installations that will be covered, and an estimate of the proportion of energy use and carbon dioxide emissions in each sector[1].

D.4 The key results are:

- IPPC will cover sites responsible for over a half of industrial energy use and carbon dioxide emissions, or around a third from the whole of business;
- almost all SMEs and low intensity energy users are outside the scope of IPPC. As the Government's climate change consultation paper shows, these may often be the ones where the most cost-effective possibilities for improvements in energy efficiency and carbon dioxide savings exist;
- although most energy intensive users have sites covered by IPPC, IPPC coverage is not a good way of identifying energy intensive users. This is because:
  - there are many sites within IPPC that are not energy intensive (for instance, 2,000 landfill sites and some intensive livestock units;
  - there are some energy intensive users that are not covered by IPPC, especially those that are SMEs. This point was made by respondents to the consultation document.

Operation of IPPC

D.5 IPPC principally requires installations to obtain a permit from an environmental regulator based on BAT – Best Available Techniques – containing conditions requiring the reduction of polluting emissions and other environmental impacts. BAT is not a fixed standard, but varies from plant to plant according to factors such as the type and remaining lifetime of that plant, and the sensitivity of the environmental receptors around it. The Directive's definition of BAT excludes disproportionately expensive techniques because techniques are only to be regarded as "available" taking into consideration the costs and advantages. Emission limits based on BAT – or equivalent technical requirements – must be set by the permitting authority for pollutants likely to be emitted in significant quantities from an installation. The Directive contains an indicative list of such pollutants: this does not include carbon dioxide,

[1] Because of differences in data collection methodology, ETSU's figures for energy use in particular sectors may differ from that published in other sources.

but does include the other five greenhouse gases covered by the Kyoto Protocol. The Directive also contains a number of other requirements besides the BAT requirement: one of these is that account is taken of the general principle that energy is used efficiently.

D.6 Regulations are to be made during 1999 in time for the transposition date of 30 October 1999. Upon transposition, the Directive will apply immediately to new plants within its scope and to existing ones which undergo a major change. Other existing plants will be phased into the new controls sector by sector according to a schedule to be contained in regulations. This phasing process must be completed by 2007. Many of the installations concerned are already regulated under the UK's own IPC regime, Local Air Pollution Control or waste licensing. Decisions on the order of phasing will be taken during 1999.

Role of IPPC in minimising industrial energy use

D.7 No firm policy decisions have been taken yet, but one possibility is that the requirement for plants to be operated in an energy efficient manner will be fulfilled by the Environment Agency and other regulators agreeing improvement plans or proposals for new plant submitted by plant operators. The regulators will expect these plans to include all relevant energy efficiency measures where the benefits at least equal the cost, taking account of the costs of the measures and the cost of capital, the cost savings from reduced energy use, and a financial value placed on the abated emissions of pollutants, including greenhouse gases, where this is quantifiable. Regulators will be able to compare the proposed energy efficiency measures with lists of measures (and their typical rates of return) for each main industry sector, drawn up by ETSU. In addition, for sectors where data is available, they will be able to compare process energy consumption with industry benchmarks prepared by ETSU. The regulators – and regulated industry – will also be able to refer to general information in BAT Reference Notes to be published by the European Commission for each sector covered by the Directive between 1999 and 2001.

D.8 The UK could go further than the requirement to take account of energy efficiency by including carbon dioxide in the list of substances for which emission limits based on BAT must be set. This could drive stricter measures than a simple energy efficiency requirement, for example, by encouraging CHP or fuel switching. But there are a number of reasons for supposing that even requirements based on BAT for carbon dioxide reduction would not exhaust the possibilities for reducing greenhouse gas emissions open to industry:

- first, failure to meet BAT is a prosecutable offence, and so authorisation limits may tend to be a conservative interpretation of what can be achieved, especially by new technology;
- more importantly, as discussed above, IPPC is a process-based operation, and a consent will be specified in terms of environmental performance which can be achieved through changes that can be made to a particular process. But there are a number of other ways in which operators could act to reduce greenhouse gas emissions, such as reducing operating periods, retiring plant early, or switching out of more carbon intensive technologies or lines of business into less carbon intensive ones.

D.9 To expand the example given above, if a pipe is currently made from primary steel there could be several options which would reduce the energy consumption of its manufacture:

- making the steel process more efficient;
- making the pipe from less steel;
- making the pipe from recycled steel (which is less energy intensive);
- making the pipe from a different material like plastic.

IPPC would focus on making the primary steel process more efficient but would provide no incentive for the operators to take up the other options. An economic instrument, however, would provide an incentive to individual operators to take these possibilities up, and to develop new approaches which have not yet been invented.

Table D.1: IPPC coverage by sector

Sector	SIC 92 codes	Energy use (PJ) 1995	Energy used by companies liable to IPPC (PJ)	Energy covered by IPPC, % of sector	Estimated carbon dioxide emissions from IPPC sites (ktC)	Number of installations covered by IPPC[1]
Iron and steel	27[2]	335	289	86	7,400	100 – 120
Non-ferrous metals	27·4, 27·53 – 54	48	30	63	1,100	478
Non-metallic metals	14·1, 26·6, 26·8	30	3	10	70	15
Bricks	26·4	21	20	95	360	77
Cement	26·5	69	69	100	1,600	34
Glass	26·1	31	29	95	600	57
Potteries	26·2, 26·3	16	3	20	70	8
Chemicals	24	254	211	83	5,000	333
Mechanical engineering	28, 29	84	10	16	290	538
Electrical engineering	30 – 33	38	0	0	0	0
Vehicle engineering	34, 35	68	11	16	290	165
Food, drink and tobacco	15, 16	174	41	24	850	1,597
Textiles, leather and clothing	17 – 19	49	27	54	650	27
Other industries	20, 36	27	0	0	0	0
Paper manufacture and utilisation	21, 22	151	96	63	2,400	99
Plastics and rubber	25	56	3	5	80	1
Total manufacturing industry		**1,451**	**842**	**58**	**20,760**	**3,529 – 3,549**
Coke ovens		29	29	100	700	9
Oil refineries		270	270	100	5,600	16
Gas production		189	189	100	2,800	1
Waste						1,738
Agriculture						974
Total UK industries		**1,939**	**1,330**		**29,860**	**5,293 – 5,313**

Source: ETSU

Due to differences in data collection methodology, the energy use figures for individual sectors may be different from DTI data.

[1] *England and Wales only.*

[2] *except those in non-ferrous metals.*

PJ = Petajoule.

ktC = thousand tonnes of carbon.

ANNEX E: SCOPE FOR ENERGY SAVING AND EMISSIONS REDUCTIONS IN INDUSTRY

E.1 The Task Force has considered the available evidence on the scope for energy saving measures in industry. This Annex complements the evidence presented in Annex F on the responsiveness of industry's use of energy to changes in the price of energy.

E.2 The Task Force has paid particular attention to work carried out by the Energy Technology Support Unit (ETSU, part of AEA Technology plc), the Department of the Environment, Transport and the Regions' contractors for advice on industrial energy efficiency). ETSU's work is well regarded by industry: as noted above, many respondents to the Task Force's consultation document drew attention to ETSU's work in estimating benchmarks and potentials for emission savings in their sectors.

E.3 Work on other sectors outside manufacturing industry is not generally available to this level of detail: ETSU have estimates of the energy use in the energy supply industries, but have not published figures on the potential for energy savings. The Building Research Energy Conservation Support Unit (BRECSU) are working on estimates for the commercial sectors, but do not yet have detailed projections for the energy saving potential in 2010.

E.4 ETSU specialists developed projections of energy use and emissions under three scenarios:

- Business as Usual (BAU). An assumed continuation of current trends;
- All Cost Effective (ACE) energy saving measures taken up in each sector;
- All Technically Possible (ATP) energy saving projects undertaken now.

These scenarios are explained further below.

E.5 Table E.1 shows ETSU's estimates of the potential for energy saving potential in industry sectors in 2010 (this period seemed most relevant to the Task Force's considerations as it corresponds to the first commitment period under the Kyoto Protocol). It shows that there is considerable scope for cost-effective energy saving measures in all sectors, including those identified as energy intensive. Table E.2 shows the implications for carbon dioxide emissions.

Notes to the Tables

E.6 The second column in Table E.1 shows the estimated energy consumption in each sector in 2010 assuming no new major changes are introduced that affect industry's behaviour (BAU). It is assumed that current Government programmes such as the Energy Efficiency Best Practice Programme would continue at current levels, and there would be no significant change in energy prices. Economic growth is assumed to follow past trends. In practice, these estimates reflect a continuation of past trends in energy efficiency improvements within the limits of technological availability.

E.7 The fourth column shows the estimated energy consumption which would result if all cost-effective energy efficiency measures (including CHP) were installed by 2010 (ACE). It assumes rapid take-up of all relevant measures, leading to 100 per cent penetration of all suitable technologies when they become cost-effective to install, taking into account the age of existing plant. The estimates are derived by considering all of the possible technologies available to each sector, with the payback for each compared against that generally acceptable in the industry. Energy prices are assumed to remain approximately constant in real terms.

E.8 In practice, industry often makes a distinction between retrofit and rebuild projects. The payback criteria are different for each, and this is incorporated within the model as far as possible. Typically, retrofit projects are expected to have a simple payback of up to two years,

while rebuild projects may have a payback period of two to four years – perhaps longer for strategic investments in new plant. Rebuild technologies are often cost-effective only when the old plant to be replaced has reached the end of its working life. This is taken into account in the model.

E.9 The fifth column shows the potential energy consumption for each sector if all *currently available* technologies were installed, regardless of cost (ATP). The only consideration is that the technologies are available industry-wide. It is assumed that all existing plant is replaced by state-of-the-art alternatives, and that process routes are optimised for energy efficiency considerations alone. Capital constraints are ignored. The result is an estimate of the minimum energy required by a sector at a given level of output. This scenario shows the current technological limit of emissions abatement, and thus sets an upper bound on the emissions savings possible *with current technologies.*

Table E.1: Projected energy use in 2010 and potential for energy savings

Sector	SIC 92 codes	Forecast energy use in 2010 (Petajoules)				Energy efficiency potential (% of business as usual)		Energy efficiency potential (Petajoules)	
		Business as Usual	as % of total	All cost effective	All technically possible	All cost effective	All technically possible	All cost effective	All technically possible
Iron and steel	27[1]	299	18·9	275	250	8	16	24	49
Non ferrous metals	27·4, 27·53 – 54	50	3·2	42	34	16	32	8	16
Non metallic minerals	14·1, 26·6, 26·8	29	1·8	21	19	28	34	8	10
Bricks	26·4	20	1·3	18	12	10	40	2	8
Cement, lime, plaster	26·5	78	4·9	70	67	10	14	8	11
Glass and glassware	26·1	27	1·7	22	17	19	37	5	10
Pottery	26·2, 26·3	18	1·1	13	11	28	39	5	7
Chemicals	24	293	18·6	270	239	8	18	23	54
Mechanical engineering	28, 29	98	6·2	89	77	9	21	9	21
Electrical engineering	30 – 33	59	3·7	54	48	8	19	5	11
Vehicle manufacture	34, 35	90	5·7	80	67	11	26	10	23
Food, drink and tobacco	15, 16	177	11·2	156	152	12	14	21	25
Textiles, leather, clothing	17 – 19	49	3·1	45	38	8	22	4	11
Other industries	20, 36	34	2·2	28	25	18	26	6	9
Paper	21, 22	186	11·8	158	112	15	40	28	74
Plastics and rubber	25	74	4·7	66	60	11	19	8	14
Total		**1,579**	**100**	**1,405**	**1,227**	**11**	**22**	**174**	**352**

Source: ETSU

[1]Except those in non-ferrous metals.

Table E.2: Projected carbon dioxide emissions in 2010 and potential for savings

Sector	SIC 92 codes	Forecast CO_2 emissions in 2010 (Million tonnes of Carbon)				CO_2 savings potential (% of business as usual)		CO_2 savings potential (Million tonnes of Carbon)	
		Business as Usual	as % of total	All cost effective	All technically possible	All cost effective	All technically possible	All cost effective	All technically possible
Iron and steel	27[1]	7·73	22·2	7·27	6·61	6	14	0·46	1·12
Non ferrous metals	27·4, 27·53 – 54	1·57	4·5	1·31	1·06	17	32	0·26	0·51
Non metallic minerals	14·1, 26·6, 26·8	0·61	1·8	0·44	0·39	28	36	0·17	0·22
Bricks	26·4	0·36	1·0	0·33	0·22	8	39	0·03	0·14
Cement, lime, plaster	26·5	1·51	4·3	0·91	0·87	40	42	0·6	0·64
Glass and glassware	26·1	0·52	1·5	0·38	0·24	27	54	0·14	0·28
Pottery	26·2, 26·3	0·3	0·9	0·24	0·21	20	30	0·06	0·09
Chemicals	24	5·79	16·6	4·85	4·32	16	25	0·94	1·47
Mechanical engineering	28, 29	2·18	6·3	1·78	1·29	18	41	0·4	0·89
Electrical engineering	30 – 33	1·47	4·2	1·05	0·76	29	48	0·42	0·71
Vehicle manufacture	34, 35	2	5·7	1·49	1·03	26	49	0·51	0·97
Food, drink and tobacco	15, 16	3·57	10·3	2·77	2·53	22	29	0·8	1·04
Textiles, leather, clothing	17 – 19	1·03	3·0	0·86	0·7	17	32	0·17	0·33
Other industries	20, 36	0·7	2·0	0·42	0·38	40	46	0·28	0·32
Paper	21, 22	3·79	10·9	2·63	1·88	31	50	1·16	1·91
Plastics and rubber	25	1·69	4·9	1·47	1·32	13	22	0·22	0·37
Total		**34·8**	**100**	**28·2**	**23·83**	**19**	**32**	**6·6**	**10·97**

Source: ETSU

[1]Except those in non-ferrous metals.

ANNEX F: ESTIMATES OF EMISSIONS REDUCTIONS IN RESPONSE TO ECONOMIC INSTRUMENTS

F.1 Annexes C and E present data on energy use and energy intensity by sector, and ETSU's estimates for the scope for energy and carbon dioxide emissions saving measures by 2010. This Annex considers the scope for an economic instrument to reduce carbon dioxide emissions from the business sector.

F.2 There are two related strands to this work:

- estimates of the responsiveness of energy use by business to changes in the price of energy (price elasticities of demand);
- estimates of carbon dioxide savings from economic models of energy demand in the UK.

Responsiveness of energy demand

F.3 Typically, firms could be expected to invest in energy saving technology to the point where the marginal benefit of reducing energy costs (i.e. the financial gain from each unit less of energy used) exceeds the marginal cost (i.e. the financial cost of processes necessary to reduce energy use by a unit). An economic instrument – such as a tradeable permit or a tax – would produce an incentive to reduce energy use by raising the price of each unit of energy, and thereby increasing the marginal benefit from each unit less of energy consumed.

F.4 The price elasticity of demand for energy is a measure of the responsiveness of energy demand to changes in price. It is calculated as:

$$\frac{\text{percentage change in energy demand}}{\text{percentage change in energy price}}$$

F.5 Price elasticities are normally negative, as an increase in price encourages users to use less energy in total, and to use the energy they do consume more efficiently. Since users have more limited possibilities for reducing consumption in the short-term than in the long-term, elasticities are generally greater in the long-term.

F.6 Estimates of long-run elasticities are available from a number of sources. Table F.1 shows a number of these. They refer to *aggregate energy demand* (ie. the sum of electricity, gas, oil and solid fuel) assuming a general change in the price of energy, and incorporate any fuel switching that may occur as a result of price changes. The elasticity for any given fuel in any particular sector may therefore be somewhat different.

F.7 Table F.1 includes the elasticity previously published in *Energy Projections for the UK* (EP65). The DTI is currently in the process of producing new energy and environmental projections. Table F.1 also shows the estimated elasticity in the current DTI model. Work on the model continues, and the final figure may be different.

Table F.1: Estimates of energy demand elasticities

Source	long-run elasticity of energy demand for all industry
DTI, Energy Projections for the UK (EP 65)	– 0·4
DTI, current DTI model[2]	– 0·3[1]
Cambridge Econometrics	– 0·5[3]

[1] Excludes iron and steel.

[2] The DTI is currently in the process of producing new energy and environmental projections. Table F.1 also shows the estimated elasticity in the current DTI model. Work on the model continues, and the final figure may be different.

[3] Weighted average of individual sectors.

Sources: Cambridge Econometrics' Multisectoral Dynamic Model (MDM); Energy Projections for the UK (EP65), DTI.

F.8 Of course, all such estimates are subject to uncertainty, and available estimates cover a range, but these estimates suggest that the demand for energy is inelastic – demand falls less than proportionally in response to a price increase – but is far from zero. In practice, there will be a significant variation in elasticities across sectors and companies. This will reflect a number of things, such as the amount of effort companies devote to the control of energy costs, their energy intensity, and the availability of energy saving measures. Some of these factors are examined in Annexes C and E.

Estimated savings of carbon dioxide

F.9 Models of energy demand across the UK can be used as an input to consider the effects of an economic instrument on carbon dioxide emissions. The Task Force has examined work by the DTI, based on the model it uses to produce UK energy projections (see *Energy Projections in the UK* (EP65)). This is basically a set of interlocking models of final user energy sectors and the electricity supply industry. It is predominately a top-down model, although some sectors, including the electricity supply industry, contain detailed bottom-up data and projections. As explained above, the DTI is currently in the process of updating this model and producing new energy and environmental projections. As for estimates of elasticities, such estimates are subject to uncertainty, but can give a broad indication of potential emissions savings. In effect, by examining the response of fuel users to historical energy price changes, it can provide estimates of energy and emissions savings for possible tax changes, assuming these are passed through to final energy prices.

F.10 Preliminary modelling work carried out for the Task force by the DTI suggests that a illustrative downstream energy tax that broadly reflected the average carbon content of different fuels, and that would produce an overall tax take of around £1 billion a year, might reduce carbon dioxide emissions by around 1 million tonnes of carbon by 2010. This is 0.7 per cent of the UK's carbon dioxide emissions in 1990.

F.11 ***The tax rate chosen for the modelling is purely illustrative.*** There are various ways in which one could calculate the greenhouse gas impact of different fuels, and the exact detail of the relative rates would need to be a subject for further work and consultation.

F.12 As before, other estimates are available. One such example is provided by Cambridge Econometrics, again using their MDM model. Table F.1 shows that their estimated response of industry to changes in energy prices is higher than that in the DTI model. This means that the estimates of emissions savings will be greater.

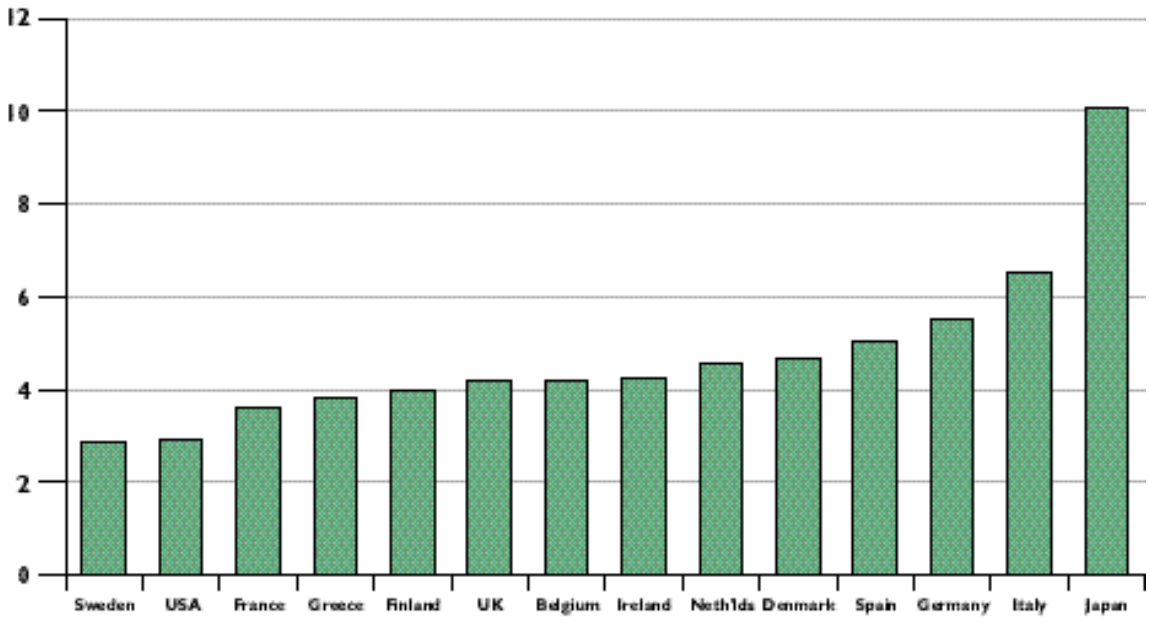
F.13 Cambridge Econometrics estimated that a downstream tax on business and commerce, with tax rates reflecting the carbon intensity of each fuel, starting at $1 per barrel of oil equivalent in 1998 and rising to $13 by 2010 (a tax at this rate is estimated to raise around £6 billion in 2010), would save around 7 million tonnes of carbon a year in 2010. This modelling also assumes that the revenues raised by a tax are used to reduce employers' NICs, and that this would lead to significant second-round changes in employment and output. The estimated emission savings include these second-round effects, and as such, are not directly comparable with the estimates produced by the DTI model.

ANNEX G: INTERNATIONAL INDUSTRIAL ENERGY PRICES

G.1 The Task Force has considered the variation in international industrial energy prices. A sample is shown in Figures G.1 and G.2. In summary:

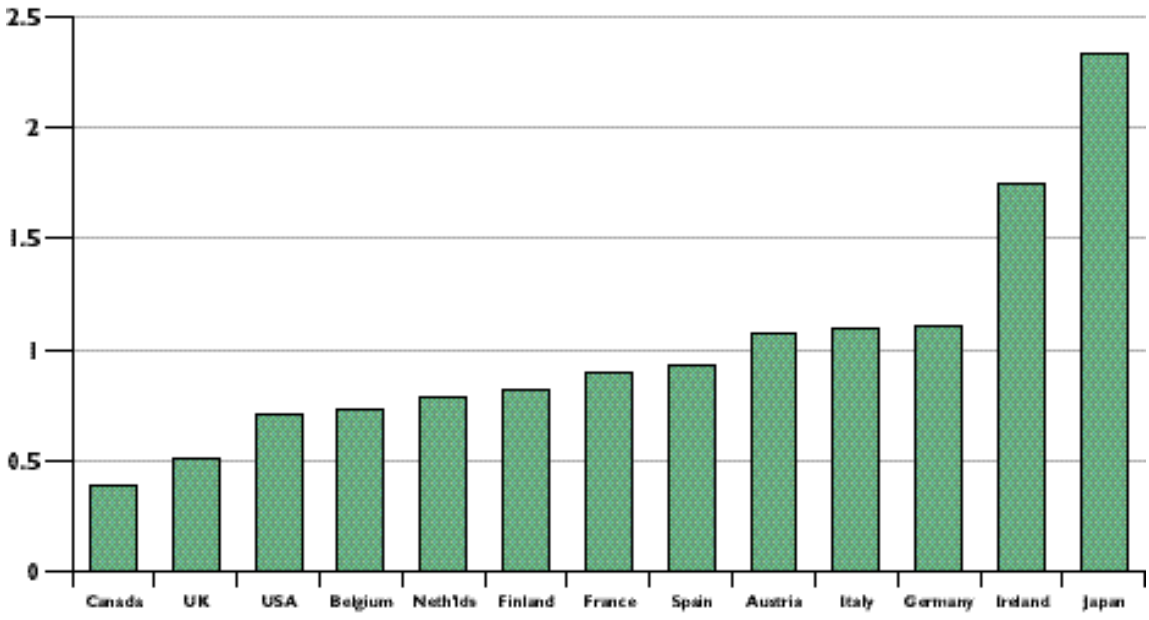
- in 1996, UK industrial gas prices were the lowest in the EU and the second lowest in the G7;
- UK industrial gas prices have been below the EU and G7 averages every year since 1981 (except 1988 for the EU);
- between 1990 and 1997, UK industrial gas prices fell by 46 per cent in real terms – the largest fall in the EU or G7;
- in 1996, the UK's industrial electricity prices are the fourth cheapest within the G7, and the fifth cheapest within the EU. However, recent exchange rate movements have meant that in 1997, UK prices were the tenth lowest in the EU despite recording the second largest real term year-on-year fall;
- between 1990 and 1997, industrial electricity prices fell by around 22 per cent in real terms in the UK.

Figure G.1: Industrial electricity prices in the EU and G7, 1996, pence per kWh



Source: Derived from International Energy Agency, Energy Prices and Taxes Q1 1998.
Prices converted to pounds sterling using annual average exchange rates.
Prices include all taxes where not refundable on purchase.

Figure G.2: Industrial gas prices in the EU and G7, 1996, pence per kWh



Source: Derived from International Energy Agency, Energy Prices and Taxes Q1 1998.
Prices converted to pounds sterling using annual average exchange rates.
Prices include all taxes where not refundable on purchase.
Prices for natural gas refer to kWh using the gross calorific value.

GLOSSARY

ACBE	Advisory Committee on Business and the Environment.
ACE	All cost effective.
ATP	All technically possible.
autogeneration	Generation of electricity by companies whose main business is not electricity generation, the electricity being produced mainly for that company's own use.
banking	Some tradeable permit schemes allow businesses to set aside permits for use in a future period. This is known as banking permits.
BAT	Best Available Techniques.
BRECSU	Building Research Energy Conservation Support Unit. Part of the Building Research Establishment.
benchmarking	Allocation based on a target rate of emissions per unit of production.
CHP	Combined Heat and Power. A highly efficient means of generating usable heat and power (usually electricity) in a single process.
CO_2	Carbon dioxide. Carbon dioxide globally contributes about 60 per cent of the potential global warming effect of man-made emissions of greenhouse gases. The burning of fossil fuels releases carbon dioxide fixed by plants many millions of years ago, and thus increases its concentration in the atmosphere.
downstream	As applied to taxation, the point at which primary and secondary fuels are sold to the final consumer. (But also used in oil and gas processes to cover the part of the industry involved after the production of the oil and gas. For example, it covers refining, supply and trading, marketing and exporting).
DUKES	*Digest of UK Energy Statistics 1998*, DTI. Available from the Stationery Office.
economic instrument	A policy instrument that works by affecting prices, such as tradeable permits or taxes.
emissions trading	Emissions trading schemes allow participants to buy or sell "rights" to emit pollution, the total target level of emissions having been previously determined by a regulator.
energy industries	Businesses involved in extraction of coal, oil and gas; refining of oil products; electricity generation; and gas transportation.
energy intensive sectors	Sectors of industry for whom energy costs represent a significant proportion of production costs or output.
energy use	Energy use of fuel mainly comprises use for lighting, heating or cooling, motive power and power for appliances. See also non-energy use.

ETSU	Energy Technology Support Unit, part of AEA Technology plc, who are the Department of the Environment, Transport and the Regions' contractors for advice on industrial energy efficiency.
feedstock	See petrochemical feedstock.
final energy consumption	Energy consumption by final user – i.e. which is not being used for transformation into other forms of energy.
fossil fuels	Coal, natural gas and fuels derived from crude oil (for example petrol and diesel) are called fossil fuels because they have been formed over long periods of time from ancient organic matter.
fuel oils	Used as fuel in furnaces and boilers of power stations, industry, in industrial heating, ships, locomotives, metallurgic operations, and industrial power plants etc.
gas oil	Used as a fuel in stationary and off-road diesel engines; burned in industrial and commercial central heating systems; used as a feedstock for the chemical industry.
grandfathering	A method of permit allocation where businesses are given permits on the basis of historical trends in behaviour. As such, it tends to favour existing, high polluting businesses over new, low polluting businesses.
greenhouse gases	A collection of gases which together maintain the temperature of the earth's surface higher than it would be in their absence. Six greenhouse gases are covered by the Kyoto Protocol. These are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.
Hadley Centre	The Meteorological Office's Hadley Centre for Climate Prediction and Research, one of the foremost climate change research facilities in the world.
IPPC	The EC Integrated Pollution Prevention and Control Directive.
joule	A generic unit of energy. It is defined as the energy dissipated by an electrical current of 1 ampere driven by 1 volt for 1 second; it is also equal to twice the energy of motion in a mass of 1 kilogram moving at 1 metre per second.
Kyoto Protocol	The UK has a commitment under the UN Framework Convention on Climate Change to return greenhouse gas emissions to their 1990 level by 2000. A protocol to the Convention was agreed at Kyoto in December 1997 which will commit the EU to an 8 per cent reduction in emissions of a basket of 6 greenhouse gases, including carbon dioxide, relative to the 1990 level over the period 2008-2012. As part of that, the UK has taken on a legally-binding commitment of a 12.5% reduction.
methane	The second most important greenhouse gas; it also occurs naturally as a component of biological cycles.

natural gas	Natural gas is a mixture of naturally occurring gases found either in isolation, or associated with crude oil, in underground reservoirs. The main component is methane; ethane, propane, butane, hydrogen sulphide and carbon dioxide may also be present, but these are mostly removed at or near the well head in gas processing plants.
NFFO	Non-fossil fuel obligation.
non-energy use	Includes fuel used for chemical feedstock, solvents, lubricants, and road making material.
NO_x	Nitrogen oxides. A number of nitrogen compounds including nitrogen dioxide are formed in combustion processes when nitrogen in the air or the fuel combines with oxygen. These compounds can add to the natural acidity of rainfall.
petrochemical feedstock	Petroleum product intended for use in the manufacture of petroleum chemicals, including plastics.
Petajoule (PJ)	A unit of energy equal to 10^{15} joules (see note on joules).
primary fuels	Fuels obtained directly from natural sources, eg coal and natural gas.
renewable energy sources	Renewable energy includes solar power, wind, wave and tide, and hydroelectricity.
secondary fuels	Fuels derived from primary sources of energy, eg electricity generated from burning coal or gas, coke.
SIC	Standard Industrial Classification in the UK. Last revised in 1992 and known as SIC92, replaced previous classifications SIC80 and SIC68. Now compatible with European Union classification NACE Rev1 (nomenclature generale des activites economiques dans les Communautes europeennes as revised in October 1990).
SMEs	Small and medium sized enterprises.
SO_2	Sulphur dioxide. Sulphur dioxide is a gas produced by the combustion of sulphur-containing fuels such as coal and oil.
tonne of oil equivalent	(Or toe). A common unit of measurement which enables different fuels to be compared and aggregated. 1 toe = 107 kilocalories 396.8 therms 41.87 Giga Joules 11,630 kWh
upstream	As applied to taxation, the point at which primary fuels are sold by their producer.

List of tables and figures