PART 2

Contents

Tables

1. Introduction

This part of the paper begins by outlining the policies which have been put in place by the Government in the context of its Climate Change Programme (DETR, 2000a) and assessing whether or not they are adequate to meet the various targets which the Government has adopted for 2010. It also considers projections of carbon dioxide (CO_2) emissions beyond 2010 in the context of the report by the Royal Commission on Environmental Pollution (RCEP, 2000), which suggests that the UK should reduce its CO_2 emissions by 60% (from 1997 levels) by 2050.

This section of the paper concludes that, in addition to substantial intensification of existing policies, they will also need to be re-oriented if the sustainable development challenges to energy policy are to be effectively addressed. Sections 3 and 4 go in more detail into the policies that are likely to be required in respect of energy demand and renewable energy sources. Section 5 reports on a modelling study which explores the economic and environmental implications of implementing the sorts of policies discussed in the previous two sections, and then goes on to consider the institutional framework that is likely to be necessary if such policies are to be effectively co-ordinated and implemented across the relevant sectors and Government Departments. Section 6 briefly analyses the possible role of nuclear power in an energy strategy and policy that is consistent with sustainable development.

A range of conclusions and policy recommendations are drawn from the analysis where appropriate. These are presented and summarised at the end of Part 1 of the paper.

2. Assessing the Adequacy of Current Emissions Abatement Policies

Greenhouse gas (GG) emission targets are currently being pursued through the Government's Climate Change Programme (CCP, DETR, 2000a), which seeks both to meet the Kyoto target (12½% reduction on 1990's level for a basket of six GGs [1995 baseline date for some GGs]) and the more demanding 20% reduction target for CO_2 (from 1990's level), both by 2010. Because the focus of this paper is on energy policy, what follows will concentrate on CO_2 emissions, which comprised 79% of UK GG emissions relative to the baseline year (1990 or 1995 for different GGs), a proportion which is projected to rise to 86% by 2020. Non-CO_2 GGs are projected to fall by 42% from their baseline year to 2020, while CO_2 emissions are projected only to fall by 4% over the same period, so the focus on CO_2 is justified in terms of both CO_2's proportion of total GG emissions and its non-decreasing baseline trend.

Projections of CO_2 emissions into the future are generally calculated by using an economy-energy-emissions model which projects economic activity into the future, with certain assumptions about world energy prices and other economic variables which are determined outside the model, and which derives energy demand by sector and fuel from this activity. The application of carbon coefficients to this energy demand then yields CO_2 emissions by sector and in total.

The CCP used new projections of energy demand and CO_2 emissions to 2020 produced by the Department of Trade and Industry in its Energy Paper 68 (DTI 2000b). However, the CCP only considered policy to 2010 against the above Government targets. This section will assess the adequacy of the policies in the CCP to reach the 2010 targets, and will then assess the projections to 2020 in the context of the 60% reduction target of the RCEP. Throughout this section (and in section 5) the DTI projections and Government estimates of carbon reductions from the CCP will be compared with CO_2 emissions projections from Cambridge Econometrics' economy-energy-environment model of the UK, which is the only model to produce independent projections which can be compared with those of the DTI. They will also be compared with the results of a carbon reduction modelling exercise carried out by Forum for the Future using this model (FFF, 2001a,b). This is so far the only detailed economy-wide study of opportunities for carbon reduction to 2010 (and 2020), and their associated costs, in the UK, which can provide a comparative assessment of the Government's CCP projections and policy outcomes.

2.1 BASELINE CONSIDERATIONS

Clearly the extent of the policies required to cut CO_2 emissions by a certain proportion from 1990's level will depend on whether, in the absence of these policies, the emissions are growing and, if so, how fast. The no-extra-policy projections of emissions are called the Base Case, against which cuts in emissions are then measured.

Table 2.1 shows the main trends in carbon emissions to 2010 and 2020, as projected in the CCP and by Cambridge Econometrics (CE). It can be seen that the Total trends from the two projections are similar to 2010, envisaging carbon reductions of 7% and 8.8% from 1990's level respectively, well short of the 20% reduction target. From 2010-2020 both projections show carbon emissions increasing (CE by 0.9% pa, CCP by 0.5% pa) so that by 2020 emissions in both cases are back close to 1990 levels. There is no sign in these projections of the UK economy moving onto a low-carbon trajectory consistent with the RCEP's 60% target reduction by 2050 of its own accord.

Table 2.1 Comparison of Government and CE Base Projections Carbon Emissions

CO_2 Emissions, mtc	**% change per year 2000-10**	**2010-20**	**% change from 1990 2010**	**2020**
TOTAL (1990 = 159.3 mtc)				
CCP	0.1	0.5	-7.0	-1.8
CE (Base)	0.0	0.9	-8.8	-0.2
of which				
Power generation				
CCP	-1.2	0.5	-34.2	-30.9
CE (Base)	1.1	0.2	-18.5	-17.2
Industry[1] & Services				
CCP	-0.4	0.0	-3.9	-3.7
CE (Base)	-1.6	0.4	-21.3	-18.5
Transport				
CCP	1.4	1.2	21.0	35.9
CE (Base)	-0.6	1.3	-2.1	11.9
Households				
CCP	0.2	0.5	5.1	10.2
CE (Base)	0.8	0.8	19.1	30.0

Notes: 1. CCP and CE include different sectors under this heading, so emissions are different
Sources: DETR 2000a, Annex C, p.181; FFF 2001b Appendix Tables A3.1.2

The overall trends mask significant differences between the projections in the trends of the main carbon-emitting sectors. In power generation the CE projections include less fuel switching than CCP, and do not include the attainment of the 10% renewables target, as CCP does, so carbon emissions are higher in 2010, but then grow less fast to 2020. In contrast, CE carbon projections for industry and services fall faster than CCP's to 2010, but then increase faster to 2020. In transport CE projections to 2010 assume some impact from the Government's integrated transport policy, which CCP does not, so CE carbon emissions are lower to 2010, and then grow at roughly the same rate as CCP's to 2020. In the household sector, both projections show growth in carbon emissions, with CE projections being greater in both time periods. From the '% change from 1990' columns it is clear that the problem sectors in terms of carbon emissions are transport and households, both of which show considerable increases over 1990's level by 2020 and, without successful transport policies as assumed by CE, by 2010 as well.

This detailed sectoral analysis is important in assessing the adequacy of the Government's policies for carbon emissions reduction in the CCP for two reasons. First, it shows the degree of variation in possible projections, and therefore the uncertainty with regard to Total emissions at any particular date. Second, nearly all the policies in the CCP are focused on specific sectors and the extent of their success in modifying carbon trends needs to be analysed in that context.

2.2 GOVERNMENT ESTIMATES OF CARBON REDUCTION IN THE CLIMATE CHANGE PROGRAMME

Table 2.2 shows the Government's estimates of the sectoral reductions in carbon emissions which will be achieved by the policies detailed in the CCP. These policies are described in more detail in the next two sections of this paper. Here the policies will just be noted, with some assessment of the uncertainty of the projected carbon reduction associated with them. It should be noted that the CCP allocates power station emissions to end users of electricity, which leads to the following proportions of emissions for the three main sectors for 1995: industry etc. 44%, transport 24%, households 26%. This breakdown gives a slightly misleading impression of the evolution of energy demand in electricity-using sectors. For example, with this allocation of emissions the domestic sector's increase in demand for both gas and electricity is masked by the fall in the carbon-intensity of electricity, over which households have no influence. However, it is this breakdown of emissions which is used to illustrate the impacts of the emission-reducing policies which are the major subject of the CCP.

It can be seen from Table 2.2 that estimates of savings from the 10% renewables target, the CCL, extra CHP generation and the road fuel duty increases have already been included in the baseline. However, as discussed above, it is at present by no means certain that under present conditions the Government's targets for renewables and CHP will be met, so these savings are still uncertain.

The major additional policy-related savings that are envisaged in the CCP are 2.5 mtc from the negotiated agreements associated with the CCL; 2 mtc from the recently announced emissions trading scheme; 1.3 mtc from the new building regulations; 5.6 mtc from improved vehicle efficiency (arising from a European negotiated agreement with car manufacturers) and the Government's 10 Year Plan for transport; and up to 4.3 mtc from improved efficiency in the domestic sector. Choosing a relatively high value (17.75 mtc) from the estimated range of possible emission savings, this leads to a projected carbon emissions level in 2010 that is 19% below 1990's level. The extra 1% required to reach the Government's 20% target is projected to come from unquantified savings from such sources as further action by devolved administrations and local authorities (including housing expenditure by the latter), reduced traffic speeds, voluntary carbon offset schemes and public awareness campaigns.

Table 2.2 Carbon Emissions from Different Sectors, 1990, 2010, 2020, and Possible Reductions by 2010, as projected in the Climate Change Programme

Carbon emissions mtc by sector	**Baseline projections**			**CCP**
	1990	**2000**	**2010**	**2010 possible savings**
Energy Sector[a]	**59**	**42**	**44**	**-**
10% renewables				*in baseline (2.5)*
Business & Commerce	**67**	**56**	**58**	**6.3**
Climate Change Levy (CCL)				*in baseline (2)*
CHP				*in baseline*
Emissions trading				*at least 2*
Energy efficiency/ IPPC/CCL fund				*0.5*
Voluntary agreements				*2.5*
Building regulations[b]				*1.3*
Public Sector *Central government, Schools, NHS*	**9**	**7.1**	**7.1**	**0.5**
Transport	**39**	**45**	**50**	**5.7**
Road fuel duty increase				*in baseline (1-2.5)*
Car fuel efficiency				*4*
Integrated transport policy (10 Year Plan)				*1.6*
Sustainable distribution (Scotland, Wales)				*0.1*
Domestic	**43**	**39**	**40**	**3.9-5.2**
Energy efficiency (existing buildings, appliances)				*3.0-4.3*
District heating CHP				*0.9*
Building regulations (new buildings)				*under business*
Land use & other	**10**	**6.8**	**5.4**	**0.6**
Afforestation				*0.6*
TOTAL	**168**	**154**	**161**	**15.1-18.3** **17.75** [d]
Savings from 1990 level		**14 (8%)**	**7 (4%)**	**31.75 (19%)**

a. Emissions from this sector (e.g. from electricity generation) are included in those of the end user sector (e.g. which use the electricity)

b. Includes carbon savings from building regulations in domestic sector

c. Includes district heating CHP
d. This is the figure from the range which is given in the CCP as the likely carbon reduction

Clearly there are substantial uncertainties associated with both the projected savings themselves and their realisation, in addition to the uncertainties in the baseline projections. Detailed monitoring of the effects of the policies and the subsequent trends in carbon emissions, compared to the projections, will be required as the decade proceeds in order to assess whether the policies are having their estimated effect and whether the 20% target will be attained.

2.3 CARBON REDUCTIONS IN THE DOMESTIC SECTOR

Of all the sectors, the savings estimated for the domestic sector are the least well specified in policy terms and deserve further scrutiny. It was noted above that, due to the growth of household energy demand, household CO_2 emissions present a significant challenge to Government targets, and one which may have been understated in the Government's projections. It is to investigate this situation that a programme of household energy efficiency measures was formulated as an input into the Cambridge Econometrics (CE) model, to see to what extent they could change the trend of increasing carbon emissions. The results from this modelling exercise (which are described in full in FFF 2001b) may be compared with the Government's estimates of potential energy savings from its Energy Efficiency Commitment (EEC, formerly EESOP4) programme for 2002-2005 (DETR, 2000b), and the New HEES Programme (DETR, 1999), which were a major input into the CCP estimates in this sector.

EEC 2002-2005 envisages that the electricity and gas supply companies should carry out, over 2002-2005, energy efficiency measures in the household sector to a value of about £3.50 pa for each gas and electricity customer. The modelling exercise envisaged measures rising by 2005 to a value of about £5.00 pa for each gas and electricity customer, and remaining at that level to 2020.

DETR (2000b, Table 1, p.27) estimates the number of measures (counted in millions of installations)which EEC 2002-2005 might deliver, and calculates the associated carbon savings as 0.46 mtc. FFF (2001b) uses the derived carbon saving per million installations figure to calculate the implied carbon savings from the measures in the modelling exercise. This projects significant energy savings up to 2010 from cavity wall insulation (CWI), retrofitted condensing gas boilers (CGBs), loft insulation and compact fluorescent lights (CFLs). By 2010 maximum penetration of CWI and CFLs has been achieved, so that the savings thereafter to 2020 are concentrated in CGBs and loft insulation.

In total the modelled measures in the FFF study lower CO_2 emissions by 2.1 million tonnes of carbon (mtc) pa by 2010, and 5.2 mtc pa by 2020, compared to the Base Case. In the UK Climate Change Programme (DETR, 2000a, p.104), as summarised in Table 1.2 above, the Government lists its expectations of carbon savings from measures in the household sector such as those included in FFF modelling as follows:

	mtc
Programmes such as the EEC	2.6-3.7
Appliance standards and labelling	0.2-0.4
New HEES	0.2
Total	**3.0-4.3**

On the basis of the modelling results, as well as of the estimates from EEC 2002-2005, these projected savings seem very optimistic. Five times the savings of EEC 2002-2005 would need to be achieved in further EEC or HEES programmes from 2005-2010. It is not at all clear that these programmes are able to deliver such savings, which thus remain a considerable source of uncertainty for the achievement of the Government's carbon reduction target in this sector. Further, as yet unannounced, programmes for improving household energy efficiency, which would achieve maximum penetration by 2010 of CWI and CFLs, and the other measures envisaged in the modelling exercise, are likely to be required. So is an increase in the price of household energy, both to reduce household energy demand directly, and to encourage both the development and uptake of a new generation of energy efficiency technologies beyond those that have been considered up to 2010. These are among the many policy issues which are discussed in more detail in the next section.

3. Reducing Energy Demand: Policies for Energy Efficiency

3.1 INTRODUCTION

Issues of energy demand are important for three over-arching reasons. First, managing energy demand could greatly reduce the challenge of supplying enough low-carbon energy to cut emissions by 60% by 2050. Second, the technical and economic potential for improving energy efficiency in all sectors of the economy is very large. Studies have repeatedly demonstrated the existence of ‘no-regrets’ opportunities, where investment in energy efficiency is highly profitable for individuals and organisations, even when the wider social benefits are ignored. Third, energy efficiency has historically been marginalised within energy policy, both in terms of resources and policy initiatives. This needs to be redressed if energy policy is to move from a focus on supplying energy commodities, all of which have some damaging environmental impact, to the more cost-effective and less environmentally damaging provision of energy services.

This section begins by putting energy efficiency into the broader context of energy services and energy systems. It then highlights the economic potential for energy efficiency and the nature of the barriers which prevent this potential from being realised. This leads to an argument for a co-ordinated policy mix to overcome such barriers, in which the role of economic instruments is emphasised. The subsequent sections examine the policies for energy efficiency in the main energy using sectors - business, public & commercial, domestic and transport - in more detail. The aim is not to provide a comprehensive discussion of UK policy, but to: a) highlight those aspects of the CCP where there are difficulties; b) identify areas of particular importance that should be covered by the Energy Policy Review; and c) suggest how policy may evolve in the longer term. The main points are brought together in a summary.

3.2 ENERGY EFFICIENCY, ENERGY SERVICES AND ENERGY SYSTEMS

The historical focus of energy policy and the energy industry more broadly has been the delivery of energy as a *commodity* to consumers - kWh of coal, gas or electricity. The liberalisation process has left this largely unchanged: companies compete almost exclusively on price and bulk commodity sales, while industry regulators such as OFGEM measure performance in terms of lower consumer prices, rather than lower overall bills.

But energy commodities are only useful because they can provide *energy services,* such as thermal comfort, refrigeration, motive power and light. The same level of energy service can be provided in a number of different ways. For example, thermal comfort can be provided very inefficiently by burning coal in an open grate in a poorly insulated house, or more efficiently by installing a condensing gas boiler, insulating the house and utilising passive solar heating. By improving *energy efficiency,* less energy may be used to provide the same level of energy service. This may be achieved through technological or behavioural change, but a distinction should be made between energy efficiency - using less energy to achieve the same level of energy service - and energy conservation, which may be achieved by reducing levels of energy service.

Energy services are not delivered solely by energy commodities but by broader *energy systems,* which include the infrastructures required to deliver energy commodities (pipelines, electricity grids etc.), but also the built environment, transport infrastructures and the multitude of technologies used for energy conversion (e.g. freezers, boilers light bulbs etc.). The appropriate focus for a sustainable approach to energy policy is the delivery of final energy services in a economic and environmentally efficient way. This requires energy policy to address systematically the whole energy system, and not just commodity supply.

The energy service concept is not new and energy service companies (ESCOs) are already active in the industrial and commercial market. These combine the supply of energy commodities with assistance in improving the efficiency of equipment and buildings and investment in boilers and combined heat & power. The services provided include: energy management systems; energy audits; installation, operation and maintenance of equipment; low cost finance; and fuel and electricity purchasing. For a guaranteed level of energy service provision, the contract allows the host company to lower risk, avoid capital expenditure, reduce energy costs and concentrate attention on the core business. The 20% annual growth in the ESCO market is encouraged by the broader trend towards outsourcing of non-core operations in both public and private sectors.

Energy service provision is also available to small and domestic consumers, partly as a consequence of supply companies seeking to gain market share by adding value to their core product. But here the transaction costs are high and market growth is inhibited by a number of barriers on both the supply and demand side, and by the regulatory framework for suppliers and distributors.

At present, therefore, energy service provision remains a marginal activity, largely carried out by actors other than energy suppliers. But a move to a low carbon economy will require energy service provision to become a mainstream activity of the energy industry, with expanding kWh sales no longer being the primary goal. This type of change will need to be supported and encouraged by policy intervention. More fundamentally, the focus on energy systems will require energy policy goals to become integrated into much wider areas of government activity, and in particular the long term management of building and transport infrastructures.

3.3 THE POTENTIAL FOR ENERGY EFFICIENCY

A large number of studies have demonstrated the economic potential of improved energy efficiency. In a review of the literature, the recent IPCC report suggested that up to 45% of CO_2 emissions from buildings could be reduced at negative net cost by 2010 (IPCC, 2001). UK studies suggest a cost-effective potential to reduce energy use of 35% in the domestic sector, 21% in services (public & commercial) and 20% in industry (PIU, 2001b). Some independent studies suggest that these estimates are conservative. For example, Lovins argues that many energy models use an incremental approach which neglects the potential savings from the whole system - such as when more efficient windows reduce lighting needs, lead to lower passive heat generation and consequently reduce air conditioning loads (Lovins & Lovins, 1997). Modelling results are reinforced by numerous case studies which demonstrate that investments with paybacks as short as one year are frequently overlooked (Sorrell et al., 2000).

An important feature of estimates of efficiency potential is their consistency over time. Thus the UK potential estimated above is very similar to that estimated in 1980, despite the fact that the earlier potential has largely been realised. This demonstrates the importance of technical change, a factor which is often poorly treated in economic models. The rate of efficiency improvement is also dictated by the rate of turnover of capital stock. While the bulk of passenger cars will be replaced within ten years, housing may last longer than a century. Energy efficiency policy must be linked to the investment cycle, so that abatement opportunities are maximised while minimising adjustment costs. But it is particularly important to target long-lived capital stock such as buildings, as decisions taken here will dictate the pattern of energy use for decades.

The results of modelling studies should be treated with care as the results depend finely on the framework and assumptions used. In particular there is disagreement between engineering models, which use detailed information on the performance of energy-using equipment, and macroeconomic models, which are based upon price and income elasticities. The first are more optimistic about efficiency opportunities than the second, and differences between the two play an important role in the climate debate. But it is important to note that engineering based estimates of ‘no regrets’ potential are frequently backed up by real world experience (Romm, 1997).

3.4 THE BARRIERS TO ENERGY EFFICIENCY

Since ‘rational’ individuals or organisations would adopt cost-effective improvements, it is commonly assumed that they must be prevented from doing so by a range of *barriers*. For example, the tenants of a commercial building may be charged for energy costs on the basis of space occupied rather than energy consumed, while the owner may be happy to pass the energy costs on to the tenants. Such barriers will prevent markets for energy and energy using equipment from operating efficiently, leading to opportunities being overlooked. These barriers can be pervasive, as is illustrated by the fact that 90% of UK commercial offices are leased and 70% multi-tenanted.

The relevant questions for energy policy are the nature, extent and importance of such barriers; whether government intervention is justified to overcome them; and whether and how this can be done in a manner which leads to net social benefits. The answers to these questions are rarely clear cut, but there are numerous situations in which a good case for policy intervention can be made:

- *Market failures*: Several features of the energy service market can be understood as neo-classical market failures. In particular, the market produces insufficient information about the energy performance of different technologies. When the costs of acquiring information on energy efficiency greatly exceed those for energy supply, consumers will under-invest in energy efficiency. The split incentives between landlord and tenant also represent a form of market failure.
- *Organisational failures*: Organisations commonly use high discount rates to evaluate efficiency investments, neglect life cycle costs and provide inadequate incentives for staff to use energy efficiently. While these are normal features of organisational behaviour, there may be instances where governments can intervene to the mutual benefit of both the organisation and society. For example, by providing credible and accurate information to senior management about the economic performance of energy-saving technologies, government can give confidence that certain types of investment are worthwhile.
- *Limitations on decision-making*: Individuals do not make decisions in the manner assumed by economic models, but are instead subject to severe constraints on attention, resources and their ability to process information. Energy is easily overlooked when its contribution to total costs is small. Such limitations can create an additional barrier to energy efficiency, reinforce the operation of other barriers, or set a limit to what can be achieved by policy initiatives such as information programmes.

Lying behind these specific obstacles is the recognition that energy supply and energy efficiency provide alternative means of supplying energy services, but their market characteristics are very different. Energy efficiency is not a stand-alone product but a subsidiary feature of a wide range of products and services. This means that the transaction costs of purchasing energy efficiency greatly exceed those for energy supply, creating a systematic bias against the former. A primary objective of policy intervention should be to reduce those transaction costs in a manner that leads to net social benefits. The target of the intervention can be energy suppliers, energy users, suppliers of energy-using equipment, or a combination of the three. With well designed programmes, governments can help individuals and organisations help themselves.

While some forms of intervention can be beneficial there may be other policies, such as subsidies, regulatory standards and incentives, that exacerbate the neglect of energy efficiency by consumers. For example, the regulatory framework for electricity distributors provides an incentive to network operators to maximise the volume of electricity carried. Similarly, investment in oil exploration or electricity generation is eligible for taxation benefits such as VAT recovery and reduced corporation tax, while investment in energy efficiency is not. The latter is just one aspect of a wider division between investment in energy efficiency and investment in energy supply. Supply is the responsibility of large companies with access to low-cost capital and a business interest in maximising energy sales, while efficiency is the responsibility of private consumers who lack awareness and expertise and can only access capital at relatively unfavourable rates. The purpose of focusing on energy services rather than energy commodities is to redress this balance, both within energy policy and in the wider energy market.

It is important to note that while there are good grounds for government intervention to encourage investments that are cost effective at current energy prices, this is separate from, and additional to, the broader principle of internalising environmental costs. 'Making the polluter pay' is a criterion for evaluating the contribution of energy policy to sustainable development. Any increase in energy prices to reflect environmental costs will make more efficiency investments cost effective and will focus individual and organisational attention upon energy management. This, in turn, will enhance the effectiveness of other policies to overcome barriers - the two approaches can work in synergy.

3.5 POLICY INSTRUMENTS FOR ENERGY EFFICIENCY

3.5.1 The Need for a Policy Mix

Experience suggests that approaches based on a single policy measure, such as information programmes, are frequently ineffective (Robinson, 1991). This is to be expected given the complexity of energy service markets, the multiple and diverse nature of the barriers to energy efficiency and the variety of decision-making contexts. Effective intervention therefore requires a *combination* of policies which have the potential to reinforce one another. These may include:

- *Education & moral suasion*: e.g. government awareness campaigns on climate change;
- *Information*: e.g. energy labels, home energy ratings and dissemination of best practice;
- *Regulation*: e.g. framework standards for industrial processes (e.g. BATNEEC), or minimum efficiency standards for appliances;
- *Voluntary initiatives*: e.g. environmental management schemes;
- *Negotiated agreements*: e.g. the Climate Change Agreements;
- *Subsidies:* e.g. the New Home Energy Efficiency (HEES) scheme;
- *Market transformation:* a mix of demand and supply side policies to encourage diffusion of energy-efficient equipment.
- *Economic instruments*: e.g. energy taxation, emissions trading.

For example, small and medium-sized enterprises (SMEs) may be targeted through a combination of energy taxation, investment subsidies for energy-efficient equipment, targeted information programmes (channelled through trade associations, professional bodies and other routes), supply chain pressure from large customers registered to ISO14001, and market transformation programmes for common equipment such as motors. The benefits from such a well designed, integrated policy mix should be greater than the sum of its parts.

The incentives created by energy pricing form an important element of such a policy mix. But there are many sectors where energy remains a very small proportion of total costs, where the capacity to respond to price signals is limited and where price elasticities are correspondingly low. Since, in aggregate, these account for a large proportion of total energy demand, supporting policies are needed. This is all the more the case in the household sector, where knowledge and capital are in short supply and where energy taxation may be regressive. Economic instruments and other forms of policy intervention should therefore be seen as complementary.

3.5.2 The Role of Economic Instruments

To achieve environmental sustainability in a market economy it is necessary (but not sufficient) that the environmental cost of resource use be reflected in resource prices. The transition to a low-carbon economy must therefore be encouraged by economic instruments such as carbon/energy taxation and emissions trading. Such instruments:

- Have the potential to minimise the overall cost of environmental improvement and ensure that the least cost measures are implemented first;
- Provide a continuous incentive for environmental improvement and can encourage the development of less polluting products and processes;
- Ensure that users pay the full cost of resource use, thereby encouraging economic efficiency and the substitution away from polluting activities; and
- Raise revenue which may substitute for the revenue raised from labour, income or business taxation, thereby stimulating productive activity, and provide scope for either compensating affected groups or introducing further incentives for environmental improvement.

While carbon/energy taxation has all the above features, the extent to which emissions trading internalises costs or raises revenue will depend upon the process by which the emission permits are allocated. The economically efficient approach is for the permits to be auctioned. Free allocation of permits blunts the efficiency of a trading scheme, but makes it politically more acceptable while still providing a means to minimise abatement costs. Trading is also attractive in that it can guarantee the attainment of a particular emission target. In all cases, the effectiveness of the instrument depends very much on the details of its design and implementation.

Both carbon/energy taxation and emissions trading will remain central features of climate policy for the foreseeable future. Emissions trading has gained particular prominence following the inclusion of International Emissions Trading (IET), Joint Implementation (JI) and the Clean Development Mechanism (CDM) within the Kyoto Protocol. These mechanisms have the potential to reduce the cost of meeting national emission targets by as much as 50% and should provide a clear market signal of the cost of carbon abatement. National policy must take the complexity of these mechanisms fully into account. In particular, the full benefits of international trading will not be obtained without the development of a viable national trading scheme.

The policy mix for promoting energy efficiency over the longer term is an important topic for the Energy Policy Review. The following four sub-sections review the current policy mix in the industrial, public & commercial, domestic and transport sectors and make specific suggestions on how this policy mix could evolve.

3.6 POLICIES FOR THE INDUSTRIAL SECTOR

3.6.1 The Climate Change Levy and Negotiated Agreements

An energy tax is at the centre of UK climate policy for business, commerce and the public sector. The Climate Change Levy (CCL) is a revenue neutral *downstream* energy tax applying to coal, gas and electricity consumption (oil products are exempt). It will increase the unit price of electricity by 0.43p/kWh, and that of gas and coal by 0.15p/kWh - corresponding to an 11% increase in the average price of industrial electricity and a 26% increase in the price of gas. Renewable electricity and energy from 'good quality' CHP schemes are exempt. The CCL is expected to raise £1 billion in its first year, but most of this will be returned in the form of a 0.3% cut in employers National Insurance contributions. Around £50 million will be kept for energy efficiency demonstration schemes, information programmes and subsidised energy audits, while £100 million will be allocated for 100% first year capital allowances for investments in specific energy-efficient technologies.

Firms in 41 energy-intensive sectors have entered into negotiated agreements to give them exemption from 80% of the CCL. Eligible firms are those regulated under the EU Integrated Pollution Prevention & Control (IPPC) Directive, but to comply with competition law sites that fall below the IPPC size threshold are also eligible. The agreements were negotiated between the DETR (now DEFRA) and sector representatives and are based on estimates of energy efficiency potential derived from the Energy Technology Support Unit (ETSU, 1999). They typically take the form of an energy intensity target for 2010, together with milestone targets every two years. Failure to reach the milestone will result in removal of the exemption.

The CCL and negotiated agreements represent the most important developments in UK energy efficiency policy since the 1970's. These instruments have transformed the attention paid to energy management in UK business and have placed energy efficiency on the agenda of senior management. The balanced mix of revenue neutrality and hypothecation is in line with previous recommendations of the Round Table on Sustainable Development (2000) and has been successful in overcoming, if not removing, industrial opposition. However, the extensive use of negotiated agreements has led to several weaknesses, including:

- *Efficiency*: Negotiated agreements compare badly with energy taxes in terms of economic efficiency. By using negotiated agreements to exempt a very large number of sectors from 80% of the CCL, the UK has protected the competitiveness of these sectors, but is likely to have raised the overall cost of meeting the Kyoto targets.
- *Scope*: The criterion for including sectors within a negotiated agreement is regulation under IPPC, but this represents only a crude approximation to energy-intensive industry. This means a large number of non-energy intensive firms are included, while a small number of energy-intensive firms are excluded.
- *Form*: The use of energy intensity targets creates the risk that increased output will lead to increased emissions. Provisions to allow the negotiated agreement sectors to participate in emissions trading have severely complicated the design of a pilot trading scheme.
- *Stringency*: The regulator is disadvantaged when negotiating targets due to lack of information on abatement costs, while industry has an incentive to inflate cost estimates. For many of the sectors, the data available to ETSU was very limited. On average, the 2010 targets represent 60% of the identified 'cost effective' abatement opportunities, where the latter is defined as investments with paybacks of 2-4 years. The stringency of the targets may therefore be questioned, both in terms of the percentage of opportunities taken and the strict assumptions on investment criteria.
- *Transparency and legitimacy*: The agreements were negotiated between DETR and the trade associations with practically no involvement of outside bodies. The public and NGOs have had limited access to the data and assumptions on which the targets were based. Without transparency, the legitimacy of the agreements is undermined.

The rationale for negotiated agreements is to protect the competitiveness of key industrial sectors. The impact of an energy tax like the CCL on competitiveness depends on a range of factors including the balance between energy and labour costs, the extent to which competitor countries are introducing similar measures, the extent to which a sector's products are traded, the opportunities to improve energy efficiency, and the scope for innovation (Barker & Kohler, 1998). It is hard to predict, and may often be overstated.

Since revenues from the CCL are returned via reductions in employer's National Insurance contributions, energy-intensive organisations will suffer while labour intensive organisations will gain. The CCL attracted vigorous opposition from many areas of manufacturing and its introduction coincided with export difficulties due to unfavourable exchange rates. But earlier modelling work on the introduction of a revenue-neutral carbon tax suggested that sectors with lower costs as a result of such a tax were responsible for 70% of UK exports (Ekins, 1999). This suggests that, without exemptions, the CCL could have made a positive contribution to UK competitiveness overall.

In the longer term, a transition to a low-carbon economy will require large scale structural and technological change. This will not occur if energy-intensive sectors remain protected from environmental costs. The relevant issue is the timescale for the transition, and how to manage it in the most effective way.

3.6.2 Emissions Trading

The choice of a downstream tax was dictated by fuel poverty considerations. If a tax had been applied to the fuel used in electricity generation, it would have been difficult to prevent electricity cost increases being passed on to the domestic consumer. To protect those households in fuel poverty the government chose a downstream tax on non-domestic consumers, thereby providing a blanket exemption of the entire domestic sector. Similarly, the choice of an energy tax rather than a carbon tax was dictated by concern about the impact of the latter on the coal industry and a wish to prevent windfall gains by the nuclear industry.

Whatever the merits of these decisions, they have had a profound influence on the design of a pilot emissions trading scheme. This is a *voluntary* scheme in which a financial incentive (£30 million/year) is provided by government over five years to encourage organisations to take on an emissions cap. Participating organisations will be required to make absolute reductions in emissions against a 1998-2000 baseline, with the target and the level of incentive payment being set through competitive bidding. In addition, there are provisions for the negotiated agreement sectors to use the trading scheme, subject to a variety of restrictions as they do not have an absolute emissions cap. Finally, there are provisions for organisations to undertake individual projects that reduce emissions below a 'business as usual' baseline and to sell the resulting credits into the scheme. The inclusion of project mechanisms provides a potentially powerful mechanism for using private sector finance to fund low cost abatement in sectors at such as transport and households (although not one without risks).

The position of the trading scheme in national compliance plans is paradoxical. On the one hand, the UK is the first country in the EU to launch a fully developed trading scheme and industry and government have worked constructively together to develop proposals and influence developments at the EU level. On the other hand, the proposed scheme is entirely voluntary and the constraints created by the existing policy mix have led to a complex and unusual design which may be incompatible with international trading and which contains several features which could hinder its ultimate success. In particular:

- Energy using organisations are required to take on targets for carbon emissions which include an estimate of the indirect emissions from electricity generation. This is consistent with the treatment of electricity in the CCL, but it provides no incentive for lowering the carbon intensity of generation and effectively excludes the electricity generators from participating in the scheme. The fact that estimated emissions differ from actual emissions is unlikely to be viable in the long term as it may exclude the UK from participating in international trading.

- The negotiated agreement sectors were reluctant to take on the risk of a emissions cap, but at the same time they wanted the flexibility of emissions trading. Accommodating this while ensuring environmental integrity has complicated the design of the trading scheme.
- The use of financial incentives to encourage participation in a voluntary scheme has inverted the 'polluter pays principle' into a 'pay the polluter' principle.

The combined use of the CCL, IPPC, negotiated agreements and emissions trading creates a complex policy mix in which there is considerable scope for interaction and conflict. Further complications are created by the interaction with the Renewables Obligation on electricity suppliers and the Energy Efficiency Commitment on gas and electricity suppliers, both of which include trading mechanisms. The important question is how this complex policy mix will evolve in the long term and how it can be rationalised. Several principles should guide this evolution:

- While emissions trading will grow in importance there will be a continuing role for carbon/energy taxes for smaller energy users.
- The negotiated agreements should be a transitional measure. After 2010, organisations should either be participating in a trading scheme with an absolute emissions cap, or be subject to a carbon/energy tax.
- The revenue-neutral auctioning of emission permits should be phased in over time, establishing the principle that energy users must pay for their emissions.
- The electricity generators should be able to participate directly in a trading scheme through the upstream allocation of emission permits.
- The potential for project mechanisms should be fully explored, subject to controls to ensure additionality and environmental integrity.

With upstream allocation of permits, the cost of electricity supply would rise to reflect the cost of carbon abatement measures and the net acquisition of any permits. This would incentivise both electricity generators and electricity users and would require corresponding changes to the CCL. It would also raise the difficult question of how households in fuel poverty could be protected from electricity price rises. A coherent policy mix for the business sector is therefore dependent upon resolving equity issues in the domestic sector.

3.6.3 Combined Heat and Power (CHP)

Combined heat and power sits at the intersection of energy efficiency and energy supply policy. By generating heat and electricity at very high efficiencies it offers an attractive means of reducing carbon emissions, while by providing an economic means of electricity generation it offers a promising route to increasing competition in the ESI. From the point of view of the user, however, CHP is primarily a means to reduce the cost of supplying heat and power.

CHP capacity in the UK has grown from 1.79GWe in 1998 to around 4.3GWe now. This expansion has being stimulated by technological change and energy market liberalisation - environmental policy has had little impact. The government target is for 10GWe installed capacity by 2010. Current policies to support CHP include exemption of 'good quality' CHP from the CCL, eligibility for enhanced capital allowances, a requirement to 'seriously consider' CHP in planning applications for new power stations, and the more general incentives provide by the negotiated agreements and emissions trading.

The biggest short-term obstacle to the expansion of CHP is the New Electricity Trading Arrangements (NETA). These are discussed in more detail in section 4. CHP faces much the same difficulties as renewables when exporting electricity under NETA, including the penalties imposed by balancing charges when output is unpredictable. Similarly, CHP has long been disadvantaged by high connection charges, by the lack of incentives on network operators to encourage embedded generation, and by not receiving the full benefits of their contribution to the network (e.g. avoidance of transmission losses). All these issues are currently being considered by a joint DTI/OFGEM Working Group on Embedded Generation (section 4.3.2). Unless resolved, the 10GWe target is unlikely to be reached. A long term solution will require not merely the removal of barriers to embedded generation, but the use of positive incentives. A co-ordinated approach is required to encourage a transition to a system in which embedded generation is the norm.

ETSU has estimated that, with an 8% discount rate and a high differential between fuel and electricity prices, the total economic potential for CHP is 16.8GWe (ETSU, 1997). The modelling considered competition between CHP and energy efficiency measures, but there were considerable uncertainties, particularly with regard to site specific, high temperature applications. ETSU's work suggests that the current target is around two thirds of the total economic potential. The economic potential could be increased if more positive incentives were in place, or if energy price differentials made CHP economic at lower load factors (most current sites have load factors >60%).

More importantly, ETSU only considered CHP at industrial and commercial sites. The long term potential for CHP may lie in large scale community heating. Although in widespread use in Europe, this is mostly uneconomic in the UK, as it would be necessary to replace the existing infrastructure for gas central heating. But over a 50 time horizon, the potential could be very large. Community heating could be encouraged through changes in land use planning, but there are possible drawbacks with the high losses from heat distribution. An alternative approach could be to support RD&D into micro CHP generation, based on Stirling engines. These could find niche markets in residential flats or homes for the elderly, following on from the existing penetration of engine-based CHP into hotels and leisure centres. Such developments are likely to require regulatory incentives, such as the provision of 'net metering' for domestic premises, which parallel those for embedded generation and demand site management more broadly. Micro CHP would then form one element of a transition to a decentralised electricity system in which a substantial proportion of electricity generation was at the residential level. In practice, there may be room for both micro-CHP and community heating schemes in a low carbon economy, depending on the pattern of residential and commercial development. But the guiding theme is that 'waste' heat from electricity generation should be considered a resource and used wherever possible.

3.7 POLICIES FOR THE COMMERCIAL AND PUBLIC SECTORS

In contrast to the policy glut in the manufacturing sector, energy use in the commercial (and to a lesser extent public) sector is relatively neglected in the CCP. This is a mistake, as the combined sector accounts for 10% of CO_2 emissions, which are increasing very rapidly (3.7%/year). Demand growth is fuelled both by a rapid expansion in floor space and an increase in specific energy consumption (GJ/m^2) as a result of increasing IT loads and greater use of air conditioning. With energy forming less than 1% of total costs, the impact of the CCL will be limited and will be further blunted by the prevalence of landlord-tenant barriers. The Association for the Conservation of Energy has highlighted both the problems and the inadequacy of the revised building regulations in addressing them (Scrase, 2000). It has proposed legislation that would require freeholders to bring the energy performance of their buildings to an acceptable standard within a fixed time frame. Comparable initiatives are required in the public sector, including voluntary or mandatory targets for building energy efficiency, based on standardised methodologies such as BREEAM (Baldwin & Yates, 1998)., Also important is the widespread adoption of whole life costing for new equipment purchasing and the development of market transformation schemes for office equipment such as PCs and photocopiers.

A critical issue for the longer term in this sector is the low standard of energy efficiency in new non-domestic buildings. While there are numerous examples of innovative 'green' buildings, there is a large gap between typical and best practice. In particular, the increased use of air conditioning makes many new buildings perform worse in energy terms than existing ones. While building regulations can address this problem to some extent, the real source of the difficulty lies in the organisation of the construction industry, including the linear design process, the reliance on cost-based competitive tendering, the prevalence of adversarial relationships and the incentives placed on different actors (Sorrell, 2001). The consequences include oversizing of building services equipment (leading to inefficient part load operation), reduced quality, neglect of whole life costs and the absence of integrated design. This last prevents designers from optimising the energy efficiency of buildings through exploiting the complex trade-offs between building fabric, services and fittings.

These problems are long established and widely recognised within the construction industry, but the net effect is to make high standards of energy efficiency the exception rather than the norm. There are a number of reform initiatives in the construction industry, such as partnering and value management, which have the potential to overcome these obstacles to some extent, but only if sustainability objectives become fully integrated into the reform process. At present, the reform agenda initiated by the Egan report, *Rethinking Construction*, is proceeding largely independently of sustainability concerns (Egan, 1998). This is a revealing example of the long-term consequences of lack of co-ordination and policy integration.

3.8 POLICIES FOR THE DOMESTIC SECTOR

3.8.1 The Challenge

As discussed earlier, the domestic sector is second only to transport in the challenges it presents to reducing emissions. While the carbon emissions attributed to the sector fell by some 7% over 1990-2000, this was largely due to fuel switching in domestic heating and electricity generation (DETR, 2000a). Excluding this, emissions are estimated to have increased by around 10% (PIU, 2001b).

There are three reasons why the domestic sector creates difficulties for carbon-reduction policies. The first is the existence of powerful drivers of increased energy consumption, such as increasing number of households, expansion in the number and range of domestic appliances, and the desire for higher comfort levels. As the energy efficiency of dwellings is improved, people take the opportunity to heat the whole house and thereby increase consumption. This applies to dwellings with energy efficiency (SAP) rating of 60 or more (Consumers Association, 1999). Yet many houses in the UK have a SAP rating much lower than this, indicating the very low energy efficiency of UK housing. To illustrate the scale of this problem, the English House Condition Survey estimated that upgrading all dwellings with a SAP of less than 40 to a target rating of 60 would cost around £65 billion (DoE, 1991). The increase in the number of households also affects appliance energy consumption, as does the trend to greater appliance ownership. While some markets (e.g. washing machines) are largely saturated, many others (e.g. PCs, VCRs, TVs) have substantial potential for further growth.

The second reason is the prevalence of a wide range of barriers, which prevent households from making cost effective investments in energy efficiency (Brechling et al., 1991). These include lack of information on energy efficiency, asymmetry of information between buyers and sellers (e.g. house prices do not reflect the discounted cost savings from efficiency investments), non-appropriability of the benefits of efficiency investments in rented housing, limited access to capital, and limitations on decision-making. The last is particularly important: householders rarely calculate rates of return when buying energy-efficient appliances, even though these may be highly attractive. Estimates suggest that savings of 15.9MtC/year (37%) are achievable from investments with 5-year paybacks, but implicit discount rates in the sector are much higher (PIU, 2001b).

The third reason is that 4.5 million households (18%) suffer from fuel poverty - defined as the need to spend more than 10% of income on heating to achieve an adequate level of warmth (the average is 4-5% of income) (DETR,2001b). This results from a combination of income inequality and poor quality housing. Major capital expenditures are required to update the heating efficiency of homes but, by definition, the poor do not have any capital. While expenditure on improved energy efficiency for such groups can deliver multiple benefits (health, social exclusion etc.), it has limited impact on emissions as the efficiency improvements are taken up in improved comfort. For example, the £3 billion to be spent on the new Home Energy Efficiency Scheme (HEES), which is targeted at the fuel poor, is expected to reduce emissions by only 0.2MtC/year. The number of fuel poor has dropped by 1 million since 1996 due to reductions in domestic energy prices. While this is welcome, it highlights a fundamental tension between tackling fuel poverty and providing a price signal to the domestic sector to reduce energy consumption. The government has a target of eliminating fuel poverty among vulnerable groups (old people, disabled, children etc.) by 2010, but makes no provision for increases in energy prices for environmental reasons (DETR, 2001b).

3.8.2 Ways Forward

In a context of widespread fuel poverty, energy taxation would be regressive without explicit compensation. The low price elasticity of demand that results from the presence of multiple barriers means that, in the short term at least, tax levels would need to be very high to have a significant impact on emissions (Johnson et al., 1990). At the same time, there is no prospect of curbing emissions in the domestic sector over the longer term without increasing energy price levels. The falling prices of the last decade, coupled with expectations of continuing price reductions, have undermined the effectiveness of government information campaigns and reduced the attractiveness of efficiency investments.

Resolving this dilemma requires action on four fronts. The first requirement is to ensure that the 3.8 million growth in household numbers that is projected over the next 15 years is accommodated at very high standards of energy efficiency. This growth will create demand for new houses, but also for conversion of existing houses to flats, provision of student halls of residence and so on. For new build (currently around 150000/year) it is essential to ensure that the highest standards of energy efficiency are achieved, consistent with a 100 year life in an increasingly carbon constrained world. Both the proposed EU Directive on the energy performance of buildings and the recent changes to the UK building regulations provide welcome improvements, but the latter has been criticised by the RCEP and others for not going far enough. In particular, the standard for wall insulation was not tightened as much as originally proposed. Even with these changes, UK building standards remain below those in many other European countries (CEC, 2001). Denmark provides the model here, and the aim should be to reach these standards as soon as possible.

Related to this, official figures suggest that the UK housing stock has a very slow rate of turnover, with only 5000 properties being demolished each year. This has led some commentators to suggest that if we are to achieve major (50%+) improvements in the efficiency of the housing stock over the next 50 years, the rate of turnover will need to be increased (Boardman, 1998). In practice, however, the official figures may substantially underestimate the rate of demolition (Power & Mumford, 1999). Furthermore, some care needs to be taken in comparing the energy and environmental benefits of: a) new build on greenfield sites; b) demolition and rebuild on brownfield sites; and c) conversion and adaptation. For example, demolition has substantial energy and environmental consequences of its own, while both brownfield development and conversions can avoid the need for new infrastructure (e.g. roads) and reduce transport energy demand through higher residential densities. It is essential, therefore, to ensure that building conversions achieve high standards of energy efficiency and that the energy consequences of residential planning are assessed in an integrated way.

The second requirement, of which the issue of conversions is a specific example, is a systematic effort to overcome barriers to energy efficiency in the domestic sector through a mix of non-price policies. These include minimum efficiency standards, direct subsidies, information campaigns, energy-rating schemes (such as mandatory requirements on mortgage lenders to conduct energy rating surveys), market transformation programmes and efficiency requirements on energy suppliers. Subsidised capital expenditure on building fabric and heating efficiency is particularly important for the fuel poor. None of these approaches are new and all feature to some extent in EU policy and in the UK CCP. In particular, the New HEES scheme provides a major expansion of funding in this area, while the Energy Efficiency Commitment (EEC) provides an innovative market-based approach to supplier obligations. However, as discussed earlier, without extension and reinforcement, they seem unlikely to meet the 2010 targets. The important question is how they can be strengthened after 2005 (which is the time horizon for HEES and EEC) to achieve these targets, and how they should evolve in the longer term. In addition, a sustained approach to the market transformation of domestic appliances is required. Boardman et al. (1997) have shown how 2 mtc pa could be saved from domestic appliances and lighting with no loss of service or financial penalty. But this would require a substantially more ambitious programme than is currently envisaged.

The third requirement is to explore the conditions under which domestic energy taxation could be introduced, or the ESI be included in an upstream trading scheme. From a sustainable development perspective, the question is not whether domestic consumers should be subject to price signals, but when and how. If the timescale for eliminating fuel poverty is too long, taxation could be introduced with compensating measures to offset distributional impacts. There is a range of choices on how to distribute the revenues from taxation (and auctioned permits), including reductions in income tax or lump-sum redistribution through the social security system. The latter would be complex to implement, but studies have show how such a package could provide a positive net impact for low-income groups (Johnson, McKay & Smith, 1990). A number of supporting approaches are possible, including council tax rebates, differential tariff structures or changing the balance between standing and unit charges in energy bills.

The final requirement is to encourage energy suppliers to move more rapidly to the provision of energy services - with the long term objective of ensuring that energy services become the only responsible and acceptable way to sell domestic energy (DTI, 2000d). Work by the European Commission and the DTI has shown that energy services provision has yet to become established in the domestic market and suggests that it will only do so with policy support on both the demand and supply side, together with changes in electricity and gas market regulation (DTI, 2000d; Chesshire, 2000). In particular, the rule that allows customers to change suppliers after 28 days appears to be inhibiting the development of energy service contracts. OFGEM has yet to take a proactive approach to energy services, and is only likely to do so when there is a broader shift in government policy with regard to the balance between economic, social and environmental objectives.

3.9 POLICIES FOR THE TRANSPORT SECTOR

Transport currently accounts for 23% of UK GHG emissions and 34% of final energy demand and carbon emissions are growing faster than from any other sector. The sector has a multiplicity of social and environmental impacts and is widely recognised as presenting the most complex and challenging obstacle to the transition to a low-carbon economy. The government's 10 Year Plan for transport represents a major step forward in integrating environmental objectives, and replaces the 'predict and provide' approach to transport planning with a policy of active demand management. In particular, the £180 billion investment programme represents more funding for public transport than at any time over the last 50 years. But even this comprehensive package is estimated to reduce carbon emissions by no more than 1.6MtC/year by 2010 (3.8% of current transport emissions).

A comprehensive evaluation of transport policy is beyond the scope of the Energy Policy Review and only a fraction of the relevant issues can be highlighted here. But it is essential that transport does not become sidelined in the Energy Policy Review in favour of traditional energy policy issues. Transport exemplifies the energy systems approach that must guide future policy. The realisation of a low-carbon economy will require energy issues to become fully integrated into all aspects of transport decision-making.

3.9.1 Drivers of Transport Growth

A useful framework with which to analyse the climate impacts of transport is to decompose the drivers of transport emissions as follows:

- *Activity*: The aggregate volume of transport demand, measured in passenger or tonne km. This depends on geographical factors, such as the average distance between home and work, and income factors such as the demand for foreign holidays.
- *Modal structure*: The percentage of passenger (or tonne) km taken by different modes of transport - car, bus , walking etc.
- *Energy intensity*: The energy use of each mode per passenger (or tonne) km, which depends on the technical efficiency of vehicles, and on load factors and operating conditions.
- *Carbon intensity*: The carbon emissions per unit of energy use in each mode, which depends on the fuel mix.

There is a wealth of research that uses this framework to analyse historical trends in transport energy use and to project future trends (Schipper et al., 1992). Two strong messages from this work are that: first, limited improvements in the carbon and energy intensity of individual modes have been more than outweighed by increases in activity and shifts to more energy-intensive modes; and second, only a balanced strategy that aims to change *all* the above factors can have a significant impact on energy use and carbon emissions. The relative importance of different factors will depend on the time horizon. While energy intensity should be given emphasis in the short term, it is likely that sustainable development in the longer term will require an absolute reduction in transport activity.

The decomposition framework can be extended by recognising that (as with energy) transport is rarely desired as an end in itself, but only as a means to provide services, and in particular *accessibility* to employment, retail and leisure activities. As with energy services, the level of transport service provision is difficult to quantify, but should become the primary focus of transport policy. To take one example, retail services may be provided through out of town superstores, or through small and accessible local shops. While the former has advantages of economies of scale and simplifies the logistics of freight movements, it generates considerably more vehicle km. As well as reducing energy use and environmental impacts, a move to local retailing may help revitalise urban communities and overcome social exclusion by providing improved accessibility to low income groups. Reversing current trends in this and other areas requires the co-ordination of a range of fiscal, energy, transport and land use planning policies at international, national, regional and local levels. Above all, it requires that the external costs of congestion and energy use be reflected in the relative and absolute costs of transport modes. While some measures may be unpopular, there is considerable potential for win-win combinations that bring economic, social, health and environmental benefits to society overall.

The following provides some comments on energy intensity, modal structure and activity levels, in the context of both the CCP and the long term, with particular focus on the role of economic instruments.

3.9.2 Energy Intensity

In the short term, improving road vehicle fuel efficiency is the most effective means of reducing transport emissions. With 86% of passenger km from cars, a 10% improvement in fleet average fuel efficiency could reduce energy use for passenger transport by some 8.5%. To achieve a comparable reduction through a modal shift to bus travel would require an increase in bus passenger km of around 375% (assuming current vehicle efficiencies and occupancy levels). This compares to the 10% increase that is forecast from the 10 Year Plan.

UK registration weighted new car fuel efficiency was virtually the same in 1998 as in 1985, despite a shift to more fuel efficient diesel cars. Technical improvements in vehicle efficiency over this period were largely offset by increases in engine size and vehicle weight, while the mandatory requirement to fit catalytic converters also led to increased consumption. These trends are continuing: between 1995 and 2000 the average energy capacity of new cars in the EU increased by 3.8%, while vehicle weight and engine power increased by 7.9% and 14.3% respectively (ACEA, 2000). Tighter safety standards made some contribution to these trends, but consumer preferences remain the most important driver. This demonstrates how policies to improve new car fuel efficiency must be supported with fiscal and informational measures to shift purchasing habits towards smaller and more efficient cars. Companies in particular must be targeted, as these are responsible for up to half of new car purchases. With cars in the largest size category using twice as much fuel per km as those in the smallest, this is an important route to lower emissions.

The Vehicle Excise Duty (VED) differential introduced in Budget 2000 represents a step in the right direction, but does not go far enough. In particular, extending the low rate threshold to 1500cc cars (effected in Budget 2001) is a retrograde step. A more effective means of influencing purchasing habits would be a revenue neutral taxation/incentive scheme for new car purchases. If ownership (VED) taxes were to be progressively replaced with taxes on vehicle use (fuel duty), the tax burden would more closely reflect environmental impact and low income households that made limited use of their car would benefit.

The viability of fuel duty as a policy tool has been severely damaged by the recent fuel tax protests crisis and the abolition of the annual increase in duty (the escalator). While the source of the difficulties was volatility in international oil markets, it is unfortunate that climate change objectives and the environmental rationale for the escalator were largely ignored by both the media and the government. Oil prices have now fallen, but political sensitivities are likely to prevent any early re-introduction of the escalator, despite hypothecation of revenues for public transport improvements. One lesson here is the importance of building public awareness of the threat of climate change, to support policy initiatives.

With the demise of the escalator, the voluntary agreement between the European Commission and the European car manufacturers' association, ACEA, becomes of particular importance. This aims to achieve a 25% improvement in new car fuel efficiency between 1995 and 2008, which is rather less than the 40% improvement between 1990 and 2005 that was recommended by the RCEP (RCEP, 1994). As noted earlier, the agreement is responsible for the bulk of the estimated carbon savings from transport in the UK Climate Program, a total of 4MtC/year. The scope for further technical improvements in vehicle fuel efficiency, and the policy mix that should be used to encourage this beyond 2008, are important issues for the Energy Policy Review. The existence of a number of high efficiency prototypes suggests that improvements of 50% or more on 1995 levels are achievable, but the political obstacles to negotiating such improvements at an EU level will be high. Success here is likely to depend on the credible threat of mandatory regulations if the voluntary approach fails.

3.9.3 Modal Structure

The 10 Year Plan introduces a long-term strategic approach to restrict traffic growth and encourage modal shifts, but this is only likely to be successful if the costs of public transport relative to the car fall substantially - thereby reversing the trend of the last 30 years. In contrast to the domestic sector, policies that internalise the environmental costs of car travel do not hit the poorest groups in society, since these usually do not have access to a car. The third of households who fall in this category frequently live in isolated urban estates or rural communities where the local bus service forms a vital link to the rest of the world. Continuing investment in improving bus services is therefore essential to tackle social exclusion. While the 10 Year Plan includes a doubling of funding for local authority transport schemes and grants for rural and urban bus services, the bulk of capital expenditure is for road and rail. These relative priorities may need to be reviewed in the longer term.

A new source of funding for improved public transport is the hypothecation of revenues from congestion charging and levies on workplace parking. Establishing the principle of congestion charging, together with the use of the revenues for transport improvements, is one of the most important developments in recent transport policy. Each driver on congested roads imposes delays upon everyone else which are not taken into account in personal decision-making. This means journeys are undertaken for which the benefits to each driver are less than the costs caused to everyone else. But while congestion charging is economically efficient it is politically unpopular. Early reports suggest that many local authorities are reluctant to introduce charging, and DEFRA requirements on the availability of alternatives to the car and local consent are likely to slow the pace of introduction. As with other economic instruments, successful implementation will require sustained political commitment at national and local level.

A particular weakness of the 10 Year Plan is the relative neglect of walking and cycling. There is no new investment in cycling and pedestrianisation, and no requirement to integrate them into local travel plans. Data from the National Travel Survey shows that a full third of trips are by these modes, although they only account for 6% of total distance travelled. This data also shows that 40% of trips are less than one mile, 57% less than two miles and 68% less than three miles, suggesting a considerable scope for greater reliance on walking and cycling. The government has a target of quadrupling the number of journeys by bicycle in ten years, but this would still leave the UK well behind Switzerland (15%), Denmark (18%) and other European countries. To achieve more ambitious targets will require the priority development of safe and convenient routes in urban areas, the improvement of cycle provision on trains and stations and, in the longer term, the encouragement of higher density residential housing.

3.9.4 Reducing the Need to Travel

Public transport can never match the convenience of a private car and it is not realistic to accommodate current patterns of personal mobility through shifts to bus and rail travel. The vast majority (96%) of the growth in car traffic over the last 25 years has not been through substitution away from public transport, but from increases in mobility (though not always accessibility) as a consequence of increasingly dispersed patterns of land use. Lifestyles, transport infrastructures and land use patterns co-evolve and can lock the economy into energy-intensive patterns that persist for decades. The long term challenge is to reverse these trends and develop a policy framework that has the primary objective of reducing the need to travel.

As with other areas of transport policy, there is no shortage of ideas and examples of best practice. The urban forms that promote low transport energy use frequently correlate with those that minimise energy use for space heating, as well as encouraging more viable communities (Newman & Kenworth, 1989; McLaren, 1993). Particularly important is mixed use development, which incorporates a wide range of residential, employment, retail and leisure activities, together with high urban densities. Government funded studies have shown how planning policies in combination with public transport measures could achieve reductions in emissions of 15% or more over a 20 year period (DoE & DTp, 1992). Central to such an approach is the encouragement of higher residential densities (30 - 50 hectare), perhaps through minimum government standards.

The objective of reducing the need to travel is now enshrined in Planning & Policy Guidance 13. But an appropriate question for the Energy Policy Review is whether this goes far enough and to what extent other economic changes are working against the objective of reducing travel needs. A recent example, clearly illuminated by the foot and mouth crisis, is how the closure of small abbatoirs has significantly increased the movement of livestock across the country. Similar examples include the centralisation of educational and health facilities and the balance between greenfield and brownfield development for new housing. Once again, this illustrates the importance of policy integration in managing the transition to a low carbon economy.

It is notable that the objective of reducing the need to travel has yet to be applied to freight transport. Present trends are towards rapidly increasing freight activity, modal shifts to trucks and limited improvement in vehicle efficiency. Underlying this are changing patterns of manufacturing, distribution, logistics and retail - including reduced stockholding through 'just in time' production, and the rapid growth in international trade as a consequence of globalisation and regional economic integration (the 4.5 billion tonnes of annual international trade is estimated to account for one eighth of global oil use). The increasingly complex webs of freight movement appear to be offsetting any reduction in demand due to reduced consumption of bulk materials. Some of the measures proposed in the government's sustainable distribution strategy are useful (e.g. reduced empty loading, dissemination of best practice), but overall the measures are limited and some have additional environmental impacts (e.g. 44 tonne lorries). The recent concessions on VED for freight vehicles are also unhelpful.

A longer-term strategy should seek a better understanding of the drivers of freight transport growth and to identify areas where policy intervention can help reverse current trends. As elsewhere, internalising the social and environmental costs of freight transport can help to achieve this goal. This includes bringing international shipping and aviation fuel use within the Kyoto framework.

3.10 CONCLUSIONS AND RECOMMENDATIONS

The main conclusions and recommendations from this review of energy efficiency policy are as follows:

3.10.1 Efficiency Potential and the Rationale for Intervention

- A low carbon economy will require much greater improvements in energy efficiency in all end use sectors than has been achieved in the past. It is therefore essential that the Energy Policy Review gives equal weight to issues of energy demand and energy supply. This will help redress the serious imbalance that has characterised energy policy to date.
- Energy efficiency scores highly against each of the sustainable development criteria and can simultaneously meet economic, environmental and social objectives. It is likely to be the first choice in an approach to energy policy that is consistent with sustainable development.
- Evidence suggests that energy demand could be reduced by as much as a third through investments that are cost effective at current energy prices. Internalising the environmental costs of energy use in energy prices will increase the cost effective potential and stimulate technical innovation.

  Investment in energy efficiency is inhibited by a range of market and organisational barriers. Many of these barriers can be cost effectively overcome through government intervention to the benefit of individuals, organisations and society. For instance, the Advisory Committee on Consumer Products and the Environment has recommended a family of graded energy labels, comprising: a co-ordinated energy labelling regime covering cars, homes and domestic equipment; a car rating label for fuel efficiency and CO_2 emissions; home energy rating information for purchasers of all homes; and energy rating and labelling to be extended into other product ranges. (ACCPE, 1999) An effective policy response requires a combination of policies which can act in synergy.
- A transition to a low carbon economy requires the environmental cost of energy use to be reflected in energy prices. Economic instruments such as carbon/energy taxation and emissions trading therefore have a central role to play. Concerns over equity and competitiveness have some validity, but suitable measures are available to overcome them.

3.10.2 Policies for Industry

- The CCL and negotiated agreements represent the most important developments in UK energy efficiency policy since the 1970's. But despite the positive achievements, there are concerns about the efficiency, scope, form, stringency and transparency of the negotiated agreements.
- The pilot trading scheme is important, but is severely constrained by the existing policy mix. This has led to a complex and unusual design which may be incompatible with international trading and which has several features which may hinder its ultimate success.

- The negotiated agreements should be a transitional measure. Future policy in the industrial sector should be based on a combination of emissions trading (with the progressive introduction of permit auctioning) and an upstream carbon/energy tax.

3.10.3 Policies for the Public and Commercial Sector

- The public and commercial sector is relatively neglected in the CCP, despite strong emissions growth. Measures are particularly required to overcome the landlord-tenant barrier in commercial buildings and to encourage the adoption of energy targets in public buildings.
- A critical issue is the increasing energy intensity of new non-domestic buildings. While building regulations have a role here, the delivery of innovative green buildings will require more far-reaching reforms in the organisation of the construction industry.

3.10.4 Policies for the Domestic Sector

- Energy use in the domestic sector is being driven upwards by a number of powerful trends. In addition, a wide range of barriers prevent households from making cost effective investments and the poor quality of the UK housing stock contributes to 4.5 million households suffering from fuel poverty. As a consequence, energy efficiency improvements are often taken up in improved comfort, rather than lower emissions.
- The CCP addresses these problems, but the planned initiatives may not be sufficient. Also, the reliance on lower energy prices in the fuel poverty strategy creates a conflict between social and environmental goals. Future policy requires a systematic effort to overcome barriers, strict regulations on new construction, the accelerated development of energy service provision, and the introduction of domestic energy taxes with suitable compensation measures to protect low income groups.

3.10.5 Policies for the Transport Sector

- Transport provides the greatest challenge to the transition to a low carbon economy. Long-term policy must simultaneously encourage alternative fuels, reduce energy intensity, promote modal shifts and reduce the need to travel. Energy considerations need to be integrated into all aspects of transport decision-making.
- The priority in the short term should be improving vehicle fuel efficiency through voluntary agreements or regulations. It is desirable that the fuel duty escalator be reinstated if international oil prices fall, and there is also scope for taxation/incentive schemes for new car purchases.
- The extent of changes needed for a low carbon economy may require more fundamental reforms than are included in the 10 Year Plan. At present, the plan gives insufficient priority to bus services, walking and cycling. Over the longer term, the priority must be to use land use planning to reduce the need to travel.
- Current policies are likely to be insufficient to counter powerful upward trends. This is particularly the case in freight transport where greater internalisation of external costs is required.

This review illustrates the breadth of policy measures that fall within the scope of energy efficiency policy and the challenges posed by co-ordination and integration. Much of the discussion has focused on the current CCP, but this represents only the first step. Much more ambitious measures will be required if the UK is to achieve the annual reductions in carbon intensity of more than 4% pa (up to four times current rates of reduction) which will be needed to meet a 60% reduction in carbon emissions by the middle of this century.

4. Carbon-Free Energy: Policies for Renewables

The growth in renewables will be driven by a combination of technical and policy measures. Policy must operate in two arenas: first, it must assist the market penetration of viable renewables technologies; and second, it must support the research, development and demonstration of new renewables technologies. Technical measures include making it easier to embed renewable generating capacity directly into the regional distribution network, and balancing or storing intermittent sources of electricity. Careful planning will also be key to the success or failure of renewables.

The Government is supporting a market for renewables through its new Renewables Obligation (RO) scheme. This will oblige suppliers to purchase set proportions of electricity from renewable sources by certain dates. However, the Government is leaving it to market forces and competition to decide which renewables technologies supply that obligation. In the short term this may create a renewables industry that is economically efficient on narrow financial criteria, but there may be other social and environmental reasons why an element of planned support for particular classes of renewables will be needed over the longer term. Moreover, it is essential to think what steps must be taken now to ensure a diverse and secure supply of renewably generated electricity beyond 2010.

This section begins by illustrating the scale of expansion in renewable capacity that is required over the medium to long term, followed by an analysis of current policy for both market support and RD&D. This is followed by an analysis of the barriers to renewables implementation, including planning constraints, the regulation of distribution networks and electricity trading arrangements. The main points are brought together in a summary.

4.1 BACKGROUND: RENEWABLES TARGETS

The Government target for renewables is to have 10% of UK electricity supplied from renewable sources by 2010. Under the DTI Energy Paper 68 medium economic growth scenario, total electricity generation by 2010 is anticipated at 371TWh (assuming high energy prices) or 390TWh (assuming low energy prices). This implies that generation from renewables must be at least 37.1TWh by 2010. This compares with just over 10 TWh in 1999, of which over half was large-scale hydro (DTI 2000c, Table 5.1, p.134)

There are a number of renewables technologies that are widely considered as having the potential to make a significant contribution to the 2010 target:

- Energy from waste (combustion of industrial and municipal waste, landfill gas);
- Hydro (small- and large-scale);
- Wind (onshore and off);
- Biofuels (agricultural and forestry waste, energy crops).

In the longer terms significant contributions may also be expected from:

- Wave power;
- Tidal power (basin and flow);
- Solar (photovoltaics and thermal).

During the 1990s the principal market support mechanism was the Non-Fossil Fuel Obligation (NFFO), which gave subsidies to generators using a range of new renewable technologies by guaranteeing that their power would be pruchased at a certain price. Table 4.1 shows how the average guaranteed price for different technologies fell during the five successive NFFO rounds from 7.1p/kWh to 2.1p/kWh. By NFFO-5 a number of the technologies, including landfill gas and incineration (M&IW), were broadly competitive with the 1998 average price of generation of 2.67p/kWh (though this fallen since). It is this actual experience of price reductions (though some part of them was due to a change in the structure of NFFO rather than technological improvement) that has generated confidence that further price reductions in renewables technologies will be achieved as these technologies are more widely deployed.

Table 4.1 Guaranteed Prices for Different Technologies in Successive NFFO Rounds

Technology	**NFFO-1 Price**[4]	**NFFO-2 Price**	**NFFO-3 Price**	**NFFO-4 Price**	**NFFO-5 Price**[5]
Wind: Large	10	11	4.8	3.8	3.10
Small	----	----	5.99	4.95	4.60
Hydro	7.5	6.0	4.85	4.46	4.35
Landfill gas	6.4	5.7	4.00	3.2	2.90
Sewage gas	6.0	5.9	----	----	----
M&IW[1]	6.0	6.55	4.00	2.8	2.49
M&IW/CHP[2]	----	----		3.4	2.90
Biomass (gasification)	----	----	8.75	5.79	----
Biomass (other)	----	5.9	5.07	----	----
Number of projects	75	122	141	195	261
Average price (p/kWh)	**7.10**	**7.20**	**4.35**	**3.46**	**2.71**
Contracted capacity (MW DNC[3])	152	472	627	843	1177

1 Municipal and industrial waste
2 Municipal and industrial waste with combined heat and power
3 Declared Net Capacity is the equivalent capacity of base load plant that would produce the same annual energy output.
4 The prices are the highest prices that were paid for each technology (p/kWh)
5 The average electricity pool price was 2.67p/kWh in Sept. 1998

Table 4.1 also shows that the number of projects and contracted capacity increased greatly over the NFFO rounds. However, during the 1990s the contribution from renewables rose by less than 0.1% each year to reach 2.8% in 2000 (DTI, 2000e). Achieving the 10% target will require an unprecedented acceleration in the rate of installation of renewables capacity, and in the range of technologies installed. Between 1990 and 1998 over 90% of renewables growth came from energy from waste. Under the fifth round of NFFO (September 1998) energy from waste (including landfill gas) comprised 68% of the electrical capacity contracted, while onshore wind comprised 29% (RCEP, 2000, p.76). These are the market or near-market renewables technologies. ETSU/DTI studies anticipate them continuing to provide by far the largest share (over 50%) of the 10% target in 2010 (DTI, 1999). However, energy from waste has questionable long-term potential and may conflict with policies to promote greater resource efficiency and reuse. The other near-market renewable technology is onshore wind. The UK has 6.88W/capita of wind generating capacity, placing it twelfth in the EU ranking, despite having the best resource potential (New Energy, 2001, p.36). Wind capacity must expand and the other (non-waste) renewables technologies must come through much more rapidly than in the past if the Government target is to be met.

Whether the Government's target is sufficient for the longer term can be assessed with reference to the RCEP report. This used scenarios to assess the scale of renewables growth necessary to bring about the desired 60% reduction in carbon dioxide emissions by 2050. Scenarios varied according to the reductions in electricity demand achieved and whether the demand unmet by reduced fossil-fuel use was supplied entirely by renewables or a split between renewables and nuclear/fossil fuels with sequestration. The average output for the purely renewables scenarios would have to be either 19.5GW (with 33% reduction in demand) or 44.6GW (with 25% reduction in demand) (RCEP, 2000, p.255). Note that these are the average outputs, and that the actual *capacity* (especially for intermittent renewables) will need to be larger. Assuming 60% utilisation can be achieved, the renewables capacity needed under the RCEP scenarios will be between 32GW and 75GW. It is estimated that the 10% target for 2010 would be met by 8GW of renewables capacity (DTI, 2000b, p.79). This must be expanded between four and nine times again to approach the RCEP scenarios. Compared to where we are today (i.e. 2GW of renewables capacity), renewables must expand between sixteen and thirty-seven times to approach that envisaged in the RCEP scenarios. Clearly, the Government target represents only a small step towards the RCEP's envisaged future for renewables.

4.2 CURRENT POLICIES SUPPORTING RENEWABLES

Section 4.1 giving some background information about renewables illustrated the scale of the challenge, in terms of the construction of new renewables capacity, if these technologies are to play a major role in carbon reduction. The 10% target by 2010 is a step in the right direction, but renewables expansion will need to proceed much further if it is to make a significant contribution to the achievement of the RCEP's 60% carbon reduction target. Existing policies need to be assessed in this context.

The Government has a two-pronged strategy on renewables: first, through market support; and second, through research, development and demonstration (RD&D). These two approaches will be reviewed in turn.

4.2.1 Market Support - The Renewables Obligation

The new Renewables Obligation (RO) is likely to remain in force for some time. The RO obliges electricity suppliers to source a set proportion of their electricity from renewables by certain dates, which they demonstrate by buying Renewables Obligation Certificates (ROCs) from certified renewables generators. Alternatively they can obtain ROCs from the energy regulator by paying the 'buyout price', which has been initially set at £30/MWh (DTI, 2001b, p.25). This device ensures an upper limit on the cost of the RO to consumers. The buy-out revenues will be recycled to those suppliers who have met their obligations by buying renewables, in proportion to the quantity of renewable power they have purchased.

The way the RO has been established raises two issues with important implications for the longer term: 1) a bias toward near market renewables technologies over technologies that are at an earlier stage of development; and 2) a hiatus in the obligations after 2010. These points will be discussed in turn.

Near-market bias

It has been decided that there will be no 'banding' of technologies in the obligations. The obligations will be general and will not specify types of renewable generation (other than specifying which are eligible sources under the obligation, and excluding energy from incinerating mixed waste and existing large hydro, but including landfill gas). The Government believes this will introduce competition between renewables and check price rises to final consumers. Government is reluctant to choose which specific technologies should be used to meet the obligation: it is counter to its market-led approach. It has already been seen how the current near-market technologies – energy-from-waste, landfill gas and onshore wind – will meet the majority of the obligations. Under these circumstances the RO will do little to nurture the development and commercialisation of renewables whose technical potential is promising but that are not yet price competitive. Buyout revenues might have been put to better use in supporting the development of new renewables technologies. This would partially address the consequences of the lack of banding in the obligations. The Energy Policy Review might wish to reassess the case for limited banding in order to help the market penetration of renewables at earlier stages of development. A form of banding is in any case likely to emerge because of the necessity for government to choose which new technologies to support through its RD&D programmes (see below).

The hiatus in 2010

The last obligation target is 10.4% of sales by 2011, after which it is currently proposed that the obligation will remain the same until 2027, although it may well be increased to meet more ambitious targets for renewables beyond 2010" (DTI, 2001b, p.4)). Such a vague expression of possible intent will do little to convince renewables generators of the long-term determination of Government to stimulate and support the development of markets for these technologies in the future. Yet investor confidence that markets will exist for these technologies as soon as they become commercially viable is crucial if these technologies are in fact to achieve their potential.

4.2.2 Support for Renewables RD&D

The development of new renewables technologies receives public support through the Research Councils and DTI programmes. The Government recently announced increases in support for renewables. The support amounts to £250 million over the next three years, including:

- £100m for wind, solar and wave power announced by Tony Blair in March 2001;
- £50m from National Lottery funds, mainly for offshore wind and energy crops;
- £55.5m for the Government's renewable energy research and development programme from the DTI;
- £39m support for offshore wind announced by Tony Blair in October 2000 from the DTI; and
- £12m in grants for planting energy crops from DEFRA (Hertin et al, 2001, p.4).

To put this £83m yearly average into some perspective, the two 2MW offshore wind turbines at Blyth cost around £4m (and power around 3000 average households). Oil industry investment in the UK Continental Shelf is set to be £3.5 billion this year. Royal Dutch/Shell (partners in the Blyth project) invest $5 billion a year in oil exploration and production (Royal Dutch/Shell, 2001, p.34), whilst they plan to invest $1 billion in renewables *over 5 years* between 2002-07 (ENDS, 2001). Such private sector investment in renewables represents a step change compared to levels of investment in the recent past, but the balance between renewables and fossil fuel investment budgets will have to change much further if the potential of renewables is to be realised. Given the challenge of scaling up renewables capacity over the next 50 years, policies to promote this shift towards renewables RD&D are needed now, and should– particularly comprise incentives to boost private sector investment in this area. Moreover, there ought to be a clear bridge between this RD&D activity and the market assisting measures under the RO scheme.

Bottlenecks in building viable renewables capacity, such as the planning constraints currently being experienced by onshore wind, could be side-stepped by assisting the advance of other technologies at an earlier stage of development. The recently announced capital grants support for offshore wind and energy crops are a significant step in this direction, but may need to be extended both in scale and to other technologies. Choosing which technologies to support will be difficult. Nevertheless decisions must be made, using best available techniques, such as the DTI technology Route Mapping exercise to 2020.

Obviously, RD&D must link in with the policy mix for generating the sixteen- to thirty-seven-fold increase in renewables capacity implied by the RCEP scenarios. Renewables capacity on this scale, especially from intermittent sources, poses a significant challenge to managing the security and quality of the electricity supply. RD&D effort must include the search for improved techniques for balancing distributed networks, storing electricity (e.g. batteries, fuel cells), and information systems for managing a much more complicated, distributed system (including improving state-of-the-art forecasting techniques for renewables availability). In addition to research programmes for specific technologies, a programme dedicated to researching techniques for distributed network management should be a keystone in the bridge to widespread renewables capacity in the future.

4.3 BARRIERS TO RENEWABLES IMPLEMENTATION

Barriers to the large-scale expansion of renewables demand can be found in planning and in the technical issues associated with the embedded installation of intermittent energy sources.

4.3.1 Planning Constraints

Some renewables have found it easier to obtain planning permission than others – landfill gas compared to large wind farms being an obvious contrast. A Planning Policy Guidance Note exists for renewables, and in a response to a Lords Select Committee on the European Communities 1999 report the Government said that only 11% of schemes under NFFO3 and 6% under NFFO4 had been refused planning permission, while applications had yet to be submitted for 18% of NFFO3 schemes and 46% of NFFO4 (ENDS, 1999). These figures illustrate the long lead-times for projects. NFFO4 was announced in February 1997; over two years later nearly half of the projects had not applied for planning permission. Moreover, the focus on projects rather than capacity paints an overly rosy picture about progress.

A detailed study by the Confederation of Renewable Energy Associations (CREA) into the progress of *capacity* contracted concluded that only 855MW of capacity out of the total of 3638MW contracted had been commissioned by September 2000. Some of the contracted project developers failed to get planning permission, others are delaying applying (perhaps in the hope that the planning climate will improve). If a 5% intermediate target by 2003 is to be met then the rate of commissioning will have to double according to the CREA analysis. In CREA's opinion planning remains the most significant barrier to deploying renewables (Hartnell, 2001).

The Government has asked the English regions to undertake renewables assessments and set regional targets for renewables for 2010, in a similar process to that being undertaken for housing. This was in response to the Lords report that voiced concerns about the planning bottleneck. The plan is to incorporate renewables provision in Regional Planning Guidance, that in turn will cascade into structure plans and unitary development plans. By May 2001 five of the eight regions had responded with targets ranging from 6.6% in the South-East to 14% in the East (ENDS, 2001b). It not clear whether the meeting of these regional targets would guarantee that the national target would be met. Nevertheless, the elevation of renewables to a comparable level of strategic importance as housing indicates the kind of political priority renewables will need to acquire if they are to be widely deployed by 2010.

However, stronger strategic guidance from government must be complemented by support for and commitment to renewables from local communities if onshore wind power in particular is to achieve its potential beyond regional planning targets. It is therefore essential that planning barriers caused by local hostility to renewables projects be addressed with sensitivity. Wind farms have been opposed on the grounds of both visual intrusion and noise, and there is often local opposition to proposals for waste-to-energy incinerators, because of fears of air pollution.

It may be that technological advances will help to resolve these problems. Improvements in wind technology could give greater flexibility over the siting of wind farms by making them economically viable in less windy areas, which widens options beyond the isolated upland areas where they are most visually intrusive. Advances in photovoltaic cladding materials for buildings, and offshore wind and wave power, could also provide avenues for renewables deployment that are less intrusive. Thus planning considerations need to be informed by changes in technology This underscores the need for more RD&D and illustrates why renewables commissioning cannot be left to market forces alone: on a broader social assessment, the current market favourites may not be the most desirable in the long term.

It may be possible to overcome some of the unpopularity by devising ways for local communities considering a wind project, say, to be able to acquire a sense of 'ownership' over it. The RCEP suggested that intrusive schemes such as large wind farms feeding into the grid are opposed in part because local communities do not perceive them as meeting their own needs (RCEP, 2000, pp.150-51). If benefits were to be felt locally, through lower energy prices (avoiding transmission and distribution charges) or a share of profits, then planning consent might proceed more smoothly. Local communities would also have more of a direct interest in local, renewable energy provision if it was perceived as part of a strategy of giving local communities more say in and control over the provision of their energy services. Lessons in this could be learned from the handful of community-led projects in the UK (for example, the Baywind energy co-operative near Ulverston) and experiences abroad .

More fundamentally, choices on renewables need to be put into a context of the full implications of meeting future energy demand, including climate change and the possible revival of new nuclear construction (which is discussed below). No change to current arrangements, which is the alternative against which individual projects tend to be assessed, is not in fact one of the available options.

The Government should take account of the planning issues identified above in its review of the planning system. The Commission will be commenting on the expected Green Paper on planning and will consider its likely impact on energy policy including renewable energy schemes.

4.3.2 Technical Constraints – Embedded Generation

The majority of renewables technologies are likely to be embedded into regional distribution networks rather than being connected to the grid. This is significantly different to the electrical supply system that has served the UK since the 1930s. The current system is based upon the construction of relatively few, large generators serving a national grid with passive regional distribution networks. Interestingly, this is very different to the regime that preceded the 1926 Act of Parliament creating the national grid system. That earlier regime consisted of many local generation and distribution systems and reflected a framework that at the time favoured local government provision (Hughes, 1987, pp.79-80).

The Utilities Act 2000 separated the electricity supply function from the distribution network function. A licensed Distribution Network Operator (DNO) is not able to hold a supply licence. Regulated by OFGEM, DNOs are natural monopolies, whose revenues derive from the electricity they carry on their networks and the service they provide. DNO incentives have consequently become a crucial issue for the mode of generation and supply the network will facilitate. DNOs responsible for managing electricity networks will face a more complex task with greater embedded generation, but currently they have little incentive to encourage embedded generation (nor demand side management). Developers of renewables wishing to embed into distribution networks are offered little help under existing market arrangements.

Measures as significant as the 1926 Act are needed now, but this time to support the growth in distributed renewables generation. A DTI working group has been studying the problem. It concluded that the 'present regulatory framework, financial incentives and network design approaches are not conducive' to embedded generation (EGWG, 2001, p.5).

The group identified a number of technical, financial and transparency issues that acted as barriers to embedded generation: capacity restrictions limiting connection to networks in rural areas; fault level restrictions in urban areas; design standards that mitigate against variable loads and generation; the full costs of connection reinforcement are charged to the first embedded generator to connect and not spread over to those connecting later; the DNOs have no further revenues after the initial connection charge - there are no 'use of system' charges; and there is a lack of published information about distribution networks and optimum points for embedding generation (unlike the grid, for which the National Grid Company publish seven year plans). The working group made a number of recommendations to overcome the problems of incentives and technical barriers, primarily by reforming the Distribution Price Control system. This system will be reviewed in 2002 and any changes will be implemented in 2005 and stay in place until 2010.

The DTI working group only focused on the short-term problems for embedded generation. An Embedded Generation Co-ordination Group was created in July 2001. It needs both to address these current issues and consider the longer term, because other technical and managerial problems will arise as the proportion of embedded generation on networks grows beyond 20-30% (for example balancing loads and supply).

4.3.3 Technical constraints - The New Electricity Trading Arrangements (NETA)

Existing renewables generators have reported problems arising from the recent reforms to the electricity market (Bathurst and Strbac, 2001). These are distinct from the embedding problems of prospective renewables generators. The New Electricity Trading Arrangements (NETA) were designed primarily to introduce greater competition amongst the larger generators. One of NETA's design characteristics is to penalise generators who do not honour their advance contract commitments. NETA participants who wish to avoid such exposure must know with a high degree of certainty the amount of electricity they will be producing in the future and that this is in balance with the electricity they have contracted to supply for every half hour period. Given the stochastic nature of many renewable sources of energy, especially wind, it is difficult for renewables generators to predict their output with precision. This disadvantages intermittent renewables operators under NETA (whose Balancing and Settlement Code is designed to encourage generators and suppliers to contract ahead – generators selling into the Balancing Market can expect to receive a lower price than if they had resolved imbalances in the futures market). However, in introducing NETA a number of measures were put in place to assist renewables generators:

1. They could contract directly with local suppliers, thereby by-passing NETA arrangements and penalties.
2. They could consolidate any imbalance between their contracted position and electricity generated with the imbalances of other generators – the assumption being that some would be in surplus and others in deficit such that their consolidated imbalance was less than any individual imbalance.
3. They could trade into the Balancing Mechanism.

OFGEM have been monitoring the impact of NETA on smaller generators (including renewables) following a request from the Energy Secretary in February. OFGEM reported to the DTI at the end of August (OFGEM, 2001). OFGEM found that:

- Very few small generators have joined the Balancing Mechanism;
- Utilisation of consolidation measures has been very small and that the measures on offer are perceived by small generators to be unsatisfactory;
- Earnings were down considerably compared to last year (down 26% for renewables - 27% for wind); and
- The output of smaller generators has fallen substantially on last year (down 7% for renewables - 13% for wind).

OFGEM concludes "it is too soon to say whether smaller generators generally are more adversely affected than larger ones"(OFGEM, 2001, p.17). However, elsewhere OFGEM recommends: "With lower prices for green energy, as for all energy, the Government may need to review whether targets can be met within current levels of subsidy and, in particular, the need for additional Government support for less reliable green energy". (OFGEM, 2001b)

OFGEM's views on NETA may be too sanguine. Many industry observers consider that there is sufficient evidence that NETA is disadvantaging renewables and undermining their position in electricity markets. Certainly NETA was not set up to provide a positive boost to renewables capacity, which is intended to come from the Renewables Obligation. Yet if NETA is undermining the incentives for renewables generation offered by the RO, as now seems probable, NETA surely needs to be revised. Given the huge growth in renewables which is required if they are to deliver large-scale carbon reduction, it would seem desirable for NETA's revision to incorporate provisions for NETA actually to support the deployment of renewables rather than discriminating against them or relying purely on the RO.

4.4 CONCLUSIONS AND RECOMMENDATIONS

The main conclusions from this review of renewables are as follows:

- Both the Government's 2010 target of 10% electricity generation from renewables, and the RCEP's renewables scenario to 2050 imply unprecedented rates of growth from these technologies.
- A sustainable development assessment of renewables suggests that, provided these technologies can be developed to be broadly competitive, and they are sited and deployed with sensitivity to local concerns, they are the energy supply option most consistent with the sustainable development criteria applied.
- The Renewables Obligation may not give renewables generators the required signals and incentives to develop technologies that are currently further from market competitiveness, or the confidence to plan for the long term. The introduction of technology banding should be reconsidered for the RO, and higher obligations should be set for the years after 2010.

Three barriers to the deployment of renewables threaten their short-term deployment and long-term development: planning constraints, which are especially affecting onshore wind projects, the treatment of embeddedness, and the New Electricity Trading Arrangements (NETA). Neither the 2010 target for renewables generation, nor their much greater deployment envisaged by the RCEP thereafter, will be achieved unless these problems are satisfactorily resolved.

5. The Impacts and Institutional Implications of Policies for a Transition to a Low-Carbon Economy

5.1 POLICY IMPACTS

Table 2.2 set out the policy-related carbon reductions which were projected to be delivered by the CCP. These may be compared with those which were estimated independently using the Cambridge model which was also mentioned in section 2. These estimates were derived through a modelling exercise which considered, separately and together (in a Total Programme), measures reflecting intensified policy support for renewables, combined heat and power (CHP) and household energy efficiency. Some of the household energy efficiency results were discussed in section 2.3 in the context of the Government's estimates of carbon savings from that sector.

The Total Programme also included a doubling of the Climate Change Levy (CCL) between 2010 and 2020 and the imposition of an annual 3% increase in road fuel duty (the road fuel duty 'escalator') from 2003-2010. The detail of the modelling is outside the scope of this paper, but is fully described in FFF 2001a,b. Two aspects of this modelling and its results are of interest in this context. First, the policy measures modelled include many of those which were suggested in the previous two sections as likely to be necessary to secure deep cuts in carbon emissions. Second, the results of the modelling may be compared with those in the CCP.

5.1.1 Results of the Modelling

Table 5.1 summarises and compares the results of the CE Base Case and the Total Programme (TP). It can be seen that total final energy demand is 3.3% below Base by 2010 and just under 8% below Base in 2020, so that it is little changed by 2020 compared to 2000, despite economic growth of 2-3% pa over this period. The largest reductions in final energy demand come in the Household sector, where energy demand is 5.4% lower by 2010 and 11.6% lower by 2020, and Road Transport, where the respective figures are 5.8% and 11.2%, largely due to the reintroduction of the road fuel duty escalator from 2003-2010 (which, of course, keeps road fuel prices higher than the Base after 2010 as well). Industrial and commercial demand for energy are affected by the increase in the CCL so that demand by 2020 is 2.9-5.4% lower.

The household energy efficiency measures reduce the average U-value (i.e. increase the average energy efficiency) of the UK housing stock by 2.7% and 2.8% by 2010 and 2020. The full results show that the lowest two income groups see the greatest improvements, of over 4%. Energy consumption by the three lowest income groups falls by 14-15% by 2020. However, consumption in each of the other income groups is also 6-10% below Base by 2020.

The investment in renewables means that in the TP the capacity of the electricity supply industry (ESI) is 6% higher than Base in 2005, rising to 16% higher in 2010 and 14% higher in 2020, which reflects the fact that renewable capacity in general operates at lower load factors than the CCGTs and nuclear plant which it is replacing. CCGT capacity is down by nearly 65% by 2020. Total generation is 5% lower than Base at the end of the forecast period as a result of the reduced electricity demand resulting from the household energy efficiency measures and the increases in the CCL. The increased electricity contribution from renewables comes predominantly for four technologies, onshore and offshore wind, energy crops and agricultural and forestry wastes (AFW), all of which show very large percentage increases from the Base.

Part of the increased energy efficiency in TP comes from the greater CHP electricity capacity and generation shown in the table (up by more than 50% and 120% by 2010 and 2020 respectively). The other part comes from the increased household energy efficiency, which cuts household fuel use by more than 5% and 11½% by 2010 and 2020 respectively.

The Total Programme reduces CO_2 emissions in all sectors: most in power generation through the renewables and CHP programmes and the increased CCL, such that CO_2 emissions are down by 21% and 57% in 2010 and 2020, with the latter then 64½% below 1990 levels; then in households, where the energy efficiency programme cuts 2010 and 2020 emissions by 6% and 13%, and the rate of growth of emissions over 2000-2020 from 0.8% pa to 0.2% pa; then in transport, where the re-imposed fuel duty escalator cuts 2010 and 2020 emissions by 6% and 11% and keeps the sector's emissions broadly to 1990's level by 2020; and least in industry & services, where the increased CCL directly saves about ½ mtc by 2020. In total, CO_2 emissions are below the Base by 8½% by 2010 and 23% by 2020.

The reductions mean that CO_2 emissions are 16.6% below their 1990 level by 2010. The programme further shows that it is possible for the UK to continue to reduce CO_2 emissions beyond 2010, but that this will require a commitment to renewables, such that any retired capacity beyond 2010 is replaced with generation from renewable sources, combined with higher road fuel duties, an increased rate of the CCL, and support for household energy efficiency and CHP.

With regard to SO_2 emissions, in the TP these are 16% below Base by 2010 and nearly 1% below Base in 2020. The 2010 National Emissions Ceiling Directive target of 585 kt is easily met (emissions then being 552 kt), which it was not in the Base.

Table 5.1 also shows the implications of the TP for some macroeconomic indicators, which vary from the Base due to the investment effects of the measures in the Total Programme, and various differences in taxes, the most important of which are increases in the CCL from 2010, and the re-imposition of the road fuel duty escalator at 3% pa from 2003-2010. The effects may be characterised as generally positive but small.

Table 5.1 Summary of modelling results, Base Case and Total Programme

		Base Case			Total Programme			% change from Base[1]	
		2000	2010	2020	2000	2010	2020	2010	2020
Final energy demand	mtoe	157.4	157.1	172.4	157.4	152.0	158.9	-3.3	-7.9
Total ESI capacity	GW	87.8	86.5	85.7	87.8	99.3	96.9	16.3	14.2
Total ESI generation	TWh	408.6	434.4	469.8	408.6	425.6	440.6	-0.6	-5.2
CHP elec. capacity	GWe	4.6	6.6	8.6	4.6	10.1	19.7	55	128
CHP heat capacity	GW	15.5	18.6	24.1	15.5	28.8	47.8	54	98
CHP elec. generation	TWh	20.8	29.1	38.3	20.8	44.4	84.8	53	121
CHP heat generation	TWh	66.4	78.9	99.8	66.4	121.2	201.3	54	102
Total renewables generation	TWh	14.5	23.6	24.0	13.3	60.9	147.9	168	546
of which									
Onshore wind		1.1	3.5	3.5	1.1	9.8	19.5	179	457
Offshore wind		0.0	0.0	0.0	0.0	13.3	65.9	…	…
Energy crops		0.5	0.9	0.9	0.5	8.3	21.9	872	2448
AFW		0.5	0.6	0.6	0.5	5.9	13.2	857	2036
U-value (UK average)	W/m^2K	1.223	1.083	1.050	1.223	1.054	1.021	-2.7	-2.8
Ave. household fuel use	mtoe	46.2	50.9	55.7	46.2	48.2	49.3	-5.4	-11.6
of which:									
Gas	mtoe	31.5	36.0	40.1	31.5	33.8	34.6	-6.0	-13.7
Electricity	mtoe	9.1	10.0	10.8	9.2	9.8	10.4	-2.0	-3.7
CO_2 emissions	mtc	145.6	145.7	159.5	145.6	133.1	122.9	-8.6	-23.0
% change from Base[1]					*0.0*	*-8.6*	*-23.0*		
% change from 1990					*-9.6*	*-16.6*	*-23.0*		
of which:									
Power generation	mtc	39.3	44.1	44.8	39.3	34.7	19.2	-21.3	-57.2
Households	mtc	23.6	25.6	27.9	23.6	24.0	24.1	-6.3	-13.3
Road transport	mtc	31.6	29.6	33.9	31.6	27.9	30.1	-5.8	-11.2
SO_2 emissions	kt	1366.8	659.2	432.0	1366.8	551.9	427.9	-16.3	-0.2
% change from Base[1]					*0.0*	*-16.3*	*-0.9*		
of which:									
Power generation	kt	848.2	253.1	38.5	848.2	142.2	17.7	-43.8	-54.2
GDP (growth)	%	3.1	2.3	3.0	3.1	2.3	2.9	0.17	0.21[2]
RPI	%	3.0	2.2	1.7	3.0	2.3	1.7	0.20	0.11[2]
PSNCR[3]	%	- 0.3	1.7	4.4	- 0.3	1.7	4.5	0.03pp	0.16pp
Unemployment	mill.	1.2	1.7	1.3	1.2	1.7	1.2	-0.024 mill.	-0.021 mill.
Employment	mill.	27.8	29.7	31.9	27.8	29.8	32.0	0.051 mill.	0.068 mill.

Note: 1. Due to rounding of underlying data, % change may not exactly reflect figures in the Table.
2. Difference is % change in level, rather than growth rate
3. PSNCR as a percentage of GDP at current market prices

5.1.2 Comparison of the Total Programme with the CCP

Table 5.2 compares in more detail the Government's CCP carbon emission projections for 2010, and its projected sectoral carbon emission reductions with the TP modelling outcomes.

First, it may be recalled from section 2 that CE has a lower 2010 Base Case carbon emissions projection than the CCP (145.7 as against 148.1 mtc) because of lower projected final energy demand. It was also noted earlier that in the CCP all the projected carbon savings from reduced electricity demand or switching in generation to lower carbon fuels (including renewables) are allocated pro rata to the electricity-using sectors. The same procedure is followed in two steps with the TP projections. Thus Table 5.2 shows that the TP reduces CO_2 emissions from power generation by 9.4 mtc, of which 6.0, 3.3 and 0.1 are allocated to industry & services, households and transport respectively. The carbon-saving programmes also directly save 1.6 mtc in households and 1.7 mtc in transport.

It can be seen that the projected TP carbon savings in households by 2010 are very similar to those projected in the CCP (4.9 as against 4.6 mtc). Less similar, but still comparable are the project savings in industry & services (6.0 as against 6.8 mtc), the difference being more than accounted for by such measures as the proposed Emissions Trading Scheme (ETS, estimated to save 2 mtc by 2010), which was included in the CCP projections, but not in those of the TP.

The major difference between the two projections in Table 5.2 is in the projected savings from transport. But this difference is more apparent than real. Most of the CCP transport savings come from the calculation of savings of 4 mtc from the introduction of more fuel-efficient cars. The CE modelling may be said to include these savings in its Base Case under its assumption, as discussed in section 2, of there being a significant reduction in CO_2 emissions from integrated transport policy. If this reduction of 4 mtc is removed from the CE Base projection (taking its Base Case CO_2 emissions to 149.7 mtc), and then subtracted again as projected savings from transport, the two transport projections would be very nearly the same.

The result of these sectoral similarities is that the two projections of emissions reductions in 2010 are quite similar in total: a 16.6% reduction from 1990's level in the TP, and a 17.8% reduction in the CCP (projected reductions in CO_2 emissions from land use, which were not considered in the CE modelling, took the overall CCP reduction to 19%). The 2 mtc difference in their total 2010 reduced emissions could easily be accounted for by such a policy as the ETS reducing emissions in the CCP but not the TP.

It may therefore be seen that the CO_2 emissions projected in the Total Programme are more or less consistent with the emission reductions projected in the CCP. However, it should be remembered that the TP contains 13% electricity generation from renewables (compared to the Government target of 10%), achieves the target of 10 GWe CHP by 2010 (which seems likely to require significant new policies, which have yet to be put in place), continues

New HEES through to 2010, and increases funding through the Energy Efficiency Commitment to more than twice its current level. It also reintroduces the road fuel duty escalator over 2003-2010. The conclusion of this comparison between the CCP and the TP is therefore that the Government's target of a 20% CO_2 emissions reduction from 1990 levels by 2010 is well within reach – but its achievement will require the introduction of substantial new policies, which in some cases go beyond those envisaged in the CCP, in the near future.

Table 5.2 Projections of carbon emissions and possible reductions in 2010

	Climate Change Programme		**Total Programme**	
	CO_2 emissions mtc	% change from 1990[1]	CO_2 emissions mtc	% change from 1990[1]
TOTAL BASE CASE EMISSIONS	**148.1**	**-7.0**	**145.7**	**-8.8**
Possible savings				
Power generation	-	-	9.4	-5.9
Industry & services	6.8	-4.3	6.0 (0+6.0)[2]	-3.8
Households	4.6	-2.9	4.9 (1.6+3.3)[2]	-3.1
Transport	5.7	-3.6	1.8 (1.7+0.1)[2]	-1.1
Total savings	17.1	-10.7	12.7	-8.0
TOTAL REDUCED 2010 EMISSIONS	**131**	**-17.8**	**133**	**-16.6**

Notes:
1. Due to rounding of underlying data, % change may not exactly reflect figures in the table
2. First figure in bracket is emission reduction from sector; second figure is pro rata share of reduction from power generation

Sources: DETR 2000a, pp.124-125; FFF 2001b, Appendix Table A7.1.2

The implementation of the policies discussed in sections 3 and 4, and the achievement of the kinds of results modelled above, will need strong, coherent and consistent political support for a low-carbon, or sustainable energy, future. Even if the political support is forthcoming, and there are many signs of it in the current Government, it would need to be expressed through an appropriate institutional framework, co-ordinated across a number of Government departments and agencies, for it to be effective. This framework is not yet in place. This is the issue addressed next.

5.2 INSTITUTIONS FOR A SUSTAINABLE ENERGY ECONOMY

5.2.1 Existing Institutional Arrangements

The existing institutional arrangements with respect to energy policy are fragmented. Responsibility for policy formulation is split across three Whitehall Departments: DEFRA has responsibility for climate policy, energy efficiency, and environmental protection; the DTI is responsible for energy policy and supporting energy industries; and the DTLR is responsible for transport, housing and planning. Moreover, the Treasury oversees the Climate Change Levy and Departmental budgets. The Deputy Prime Minister's office has been involved in the Kyoto negotiation process. DfID's overseas work influences the uptake of sustainable energy technologies abroad. The Energy Policy Review is being conducted by the Cabinet Office's Performance and Innovation Unit. The devolved assemblies also have some powers with respect to energy and climate policy too. Each of these departments and organisations have their own organisational culture and operate within different policy networks (Green Alliance, 2001).

Policy implementation is similarly dispersed. There are many policy initiatives and regulatory frameworks being implemented or supported by a range of different public and private bodies. The Energy Saving Trust; the Carbon Trust; the Climate Change Projects office; the Gas and Electricity Markets Authority (GEMA) and OFGEM; the Emissions Trading Authority; Customs and Excise; the Environment Agency; Energy Technology Support Unit; Buildings Research Establishment Conservation Support Unit; and local authorities. These too have their individual objectives and responsibilities, some of which sit uncomfortably, or may be inconsistent, with those of the other agencies.

A number of Parliamentary Committees (for example the Commons Trade and Industry Committee, and the Environmental Audit Committee), the RCEP, and think-tanks (for example Green Alliance) have argued that the existing constellation of organisations and distribution of responsibilities is not up to the sustainable energy challenge. Individually, the institutions may do their jobs well; but collectively they do not function in a way that exhibits the necessary capabilities (outlined below) for managing the transition to a low-carbon future. Recommendations for improving the formulation and implementation of energy policy essentially rest on: a) improving the co-ordination of energy policy; and b) elevating its political saliency.

A variety of institutional reforms to these ends have been proposed. The RCEP, echoing recommendations from the Commons Environmental Audit Committee, recommended the creation of a Sustainable Energy Agency, whose principal statutory objective would be to promote the development and implementation of sustainable energy options. (RCEP, 2000, p.190).) The Agency, that would emerge from a consolidation of some existing Departmental functions and executive bodies, would promote energy efficiency and renewable energy technologies. The RCEP preference was to recommend this new independent, executive body over any rearrangement of Whitehall responsibilities.

The Green Alliance recommended the creation of a similar, low-carbon agency (Green Alliance, 2001). However, this is part of a much wider package of solutions to the institutional question. Through dialogue with senior energy policy stakeholders inside and outside government, the Green Alliance has proposed some significant reforms to governance machinery of energy policy. A new low-carbon policy unit in the Cabinet Office would co-ordinate and integrate low-carbon policy making across Whitehall and in the regions. The political clout of this unit would be supported by a new low-carbon ministerial committee. The chairmanship would rotate amongst Secretaries of State at DEFRA, DTLR, and DTI. They would be charged with ensuring that low-carbon policy unit recommendations were taken up throughout government. Policy formulation would be facilitated by the purposeful creation of low-carbon policy networks. Dialogue within these networks would feed into the appraisal and proposal activities of the low-carbon policy unit. At the same time, implementation tasks would be made more effective by the creation of low-carbon portals. The idea of these portals – managed by the low-carbon agency – is to provide one-stop-shops for different client groups: households; business; low-carbon businesses; local authorities.

Other institutional configurations could be recommended on a number of different criteria. Any amalgamation of revised responsibilities has to be done carefully and supported sufficiently. The creation of the Environment Agency, in which the three cultures of its constituent organisations (Her Majesty's Inspectorate of Pollution, the National Rivers Authority and the waste regulatory authorities) persisted and caused problems early on, indicates the care needed in institution building. However, rather than recommend any particular institutional configuration, it seems more important at this stage to stress the capabilities that must form the foundations of any institutional reform.

5.2.2 Institutional Capabilities for a Sustainable Energy Future

Some of the general characteristics of institutions responsible for planning and delivering a sustainable energy transition are as follows:

A systems outlook and networked approach

Institutions will need the skills to specify which preconditions are necessary in the 'sociotechnical system' for a range of sustainable energy scenarios. What would the world have to be like before a range of sustainable energy-related practices made sense (Shove et al., 1998)? What infrastructure, social, economic, and technological changes are needed, for example, for walking and cycling to greatly increase their share of the journeys for which they are appropriate? What new relationships and decision-making processes will be necessary in order for energy service approaches to take off in the social housing sector (for example between appliance manufacturers, energy utilities, architects, environmental engineers, financiers, landlords, and tenants)? Institutions will then need to identify the steps needed to promote positive realignments in the preconditions *in addition* to encouraging sustainable energy practices. This set of capabilities requires dialogue with many different actors in order to synthesise an understanding of the world from many different perspectives. It also requires the identification of the opportunities and levers by which government can intervene and, working with networks of social actors, shape the sociotechnical preconditions and manage the transition to a sustainable energy future.

Co-ordination, joined-up analysis and coherent policy frameworks

Policy objectives and the suite of policy instruments available to steer long-term development will need co-ordinating across Departmental boundaries. Not only will this require good links and trust relations between Departments, but also clear and sustained political support from the centre. The same is true in the inter-governmental relations between Whitehall and the regions. The promotion of less energy-intensive agricultural practices might, for example, require co-ordination across agriculture, research, social, training, consumer, and financial policy boundaries. Accelerating the growth in renewables capacity requires policy changes in the spheres of planning, regulation of energy markets, financial policy, and technology RD&D, as well as firm and clear long-term targets.

Integration into other policy areas

In addition to cross-Departmental coordination of policies for sustainable energy, government will need to integrate carbon considerations into other policy areas. What skills will be needed in the low-carbon economy; and what are the implications for training policies? Which patterns of community development form the foundations for a low-carbon society; and what are the implications for social policy? And so on. Moreover, the impact of a policy measure on carbon emissions must become an important criterion in policy appraisal exercises. Policy options must be appraised for their carbon intensity, so that this is considered in conjunction with other objectives. Ultimately, integration could lead to Departments publishing carbon budgets alongside their financial accounts.

Learning and building support

The sustainable energy challenge may be unprecedented for a market economy. How many political systems, used to a five-to-ten year timeframe (at most), have taken on the challenge of adopting, continually re-appraising and fine tuning policies to meet objectives conceived over a fifty year time-frame? Specific pathways to reducing UK carbon intensity may not be clear-cut from the outset. The transition to low-carbon energy service infrastructures will require considerable innovation and learning: route maps will require periodic reflection and revision. Institutions will be needed that can review progress toward the sustainable energy goal, learn lessons, and modify policy in the light of experience. There may be resistance from some social actors: there will be winners and losers, and challenges from those whose interests are in the fossil-fuelled present. Constituencies of support must therefore be built up behind the goal of bringing energy use in line with sustainable development.

An international outlook

Within the European Union and beyond, UK institutions are embedded in multi-level governance systems. The scope and form of national action can be circumscribed by international convention. Therefore institutions that can argue the sustainable energy case effectively at an international level will be essential. The challenge is to negotiate a path at the international level that actively supports domestic initiatives.

The modelling results described in the previous section indicated that a combination of energy efficiency and renewables had the technical and economic potential to secure deep cuts in carbon emissions. Without institutional reforms with the capabilities here suggested it is unlikely that this potential will be realised.

5.3 CONCLUSIONS AND RECOMMENDATIONS

- Both Government data and economy-environment modelling suggest that the UK can make the transition to a low-carbon economy using a combination of energy efficiency measures and renewables which, over twenty years, will yield net benefits rather than costs to the economy.
- For the necessary policy measures to be forthcoming, however, a fundamental institutional reorganisation of bodies concerned with energy policy is likely to be required. While the Commission does not endorse any particular proposals for institutional change, a number of promising models have been put forward which seem to combine the necessary systems approach, co-ordination and integration. For instance, the RCEP has recommended that "a Sustainable Energy Agency should be set up to promote energy efficiency more effectively in all sectors and co-ordinate that with the rapid development of new energy sources". (RCEP, 2000) This is an area in which the PIU needs to make authoritative recommendations for timely implementation.

6. Nuclear Power and Sustainable Development

6.1 BACKGROUND

The history of nuclear power in the UK to 1995 was one largely of disappointment and a failure to live up to expectations.

Nuclear power emerged in this and other industrial countries in the 1950s as a by-product of nuclear weapons development, which ensured that it was well funded and that many of the challenges it faced – economic, technical and environmental – were not subject to much public scrutiny. Extravagant rhetoric from the industry at that time promised energy that was 'too cheap to meter', and large, and largely unquantified, public subsidies were granted to the industry to enable it to realise its ambitions.

By the 1970s the environmental challenges especially were becoming more obvious, and opposition from environmental organisations started to intensify. In addition, the power stations were proving far more expensive than had been expected and it was clear that nuclear electricity was not even going to be cheaper than that derived from fossil fuels. But the OPEC oil price rises caused governments to continue to regard nuclear power as a strategic necessity, as well as a core technology for the future, and they continued to subsidise it, still in a very non-transparent way, on a large scale.

In 1979 the new Conservative Government of Mrs. Thatcher declared its intention to build one new large nuclear power station every year, but the continuing escalation in both costs and public concern, resulting in record-length public enquiries, meant that by 1990 only one new station – Sizewell B – had in fact been ordered. The Government finally became disillusioned with the technology when the private sector refused at first to buy nuclear stations when the electricity supply system was privatised. A Government review of nuclear power in 1995 (HMG 1995) concluded:

- In respect of diversity of energy supply: "There is currently no case for public financial or equivalent support of new nuclear build on diversity grounds." (p.38)
- In respect of possible industrial reasons for public subsidy: "Were the Government to take steps to ensure the construction of any new nuclear power stations it would be making a substantial intervention in the markets for electricity and generating equipment. It is clear from the analysis set out in this chapter that such an intervention could not be justified on grounds of wider industrial benefits. … [The Government] concludes that to support the construction of new nuclear power plant on grounds of a possible boost to economic activity and the generation of higher overall employment would not be in the best interests of either electricity consumers or the taxpayer." (p.47)
- In respect of possible environmental reasons for new nuclear power stations: "The significant amount of additional capacity provided by new nuclear build is currently too expensive to be justified for CO_2 policy purposes alone. … The Government concludes that there is at present no evidence to support the view that new nuclear build is needed on emissions abatement grounds." (pp.29-30)

However, in respect of both diversity and security of supply, and of CO_2 emissions, the Government acknowledged that these conclusions were not necessarily immutable. For example: "In the longer term, if a need arose to make significant substantial reductions in gaseous emissions, there could be a role for new nuclear capacity beyond 2010" (p.30), and: "The Government will, however, examine the emerging fuel mix from time to time, and review the position if developments justify it." (p.38). At present nuclear power generates about 25% of the UK's electricity. This proportion will decline over the next 25 years as the first and second generation stations (Magnox and AGRs) come to the end of their design lives and are shut down (though there is some doubt over when this will actually be). It is certainly the case that if these stations were to be replaced by gas, the implications for CO_2 emissions and for the enhanced UK dependence on gas, would be profound. These are very much the issues that are now being examined by the Energy Policy Review.

6.2 RELEVANT ISSUES

The following are the issues related to nuclear power which may be considered relevant to sustainable development.

6.2.1 Financial cost

As noted above, the UK history of nuclear power has been characterised by much larger than forecast costs and construction delays. One of the principal conclusions of the Government's 1995 review of nuclear power was that nuclear power at that time could not compete against generation by CCGTs and the Government saw no reason to give it the public support that would enable it do so. However, the 1995 review was in no sense anti-nuclear. It explicitly states: "The Government believes that economic and safe economic nuclear power has a significant role to play in the electricity supply industry. It would wish to encourage private sector operators to investigate the construction of new nuclear power stations on a fully commercial basis." (p.25)

So far the private sector has no plans to build new nuclear power stations, presumably because there is still no commercial basis for such construction. Any new stations would not be of the kind built here before, but would be so-called Generation III, or even Generation IV, stations, which the nuclear industry is engaged in developing. Some of the industry cost estimates for these stations seem quite encouraging (even approaching competitiveness with gas at current prices), but it should be noted that these estimates are still purely speculative, because none of these stations has yet been built. It has to be said that the cost-overruns in respect of estimated costs in this industry in the past (even when there was experience with building a particular design of reactor) do not inspire confidence in the low cost estimates which they are now producing. At the very least such estimates will need to be subject to painstaking and independent public review and confirmation before they can be regarded as credible. At present the estimates still seem to be treated as commercially confidential, so attainment of this kind of credibility seems some way off.

The same kinds of consideration apply to estimates of cost reductions as new technologies are deployed. Such reductions will play a crucial role in comparing the cost evolution of new nuclear stations with that of other technologies such as renewables. It is clear that different assumptions need to be made for different technologies (for example, what scale of deployment would be necessary for cost-reductions to be realised?), but these must be made transparent and justified, both technologically and with reference to past performance, before estimates of cost reductions can be properly compared.

The costs referred to above are the direct financial costs of building and operating new nuclear stations to current standards. They do not include the issues referred to below, although in many cases these too can be regarded as costs, in a broader sense. One of the tasks of the Energy Policy Review will be to generate insights as to whether incurring these costs (whether or not they are or can be actually quantified), on top of the actual financial costs, would be justified by the benefits which new nuclear power stations would provide.

6.2.2 Risk

There are a number of risks (to human health and the natural environment) that arise exclusively with nuclear power among energy supply sources, because of its reliance on radiation and radioactive substances. These risks are associated with:

- The possibility of catastrophically large radiation releases through an accident, such as occurred at Chernobyl, or deliberate (war-time or terrorist) attack.
- Smaller, but more frequent, releases of low-level radiation, through small-scale accidents, or incidents, routine operations or the disposal of low-level nuclear wastes.
- Transport of nuclear materials.
- The storage and, perhaps, final disposal of high-level nuclear wastes.
- The final decommissioning of nuclear power stations.
- The possibility of nuclear materials being diverted to the production of nuclear weapons.

Notwithstanding the existence of a substantial literature on each of these topics, views on the magnitude and acceptability of the above risks vary widely, and no social consensus on them seems likely to arise within the timescale that would be required for new nuclear power stations to be built such that the UK's nuclear generation capacity was maintained (agreement for new nuclear stations would certainly have to be given within the next five years for this to be achieved). As a broad generalisation, the supporters of new nuclear build regard the above risks as challenging but manageable. The opponents regard them as inherently unmanageable and socially unacceptable.

In economic terms risk is a cost, the management of which is the bread and butter of the financial sector, especially the insurance industry. To date, no private insurers have been prepared to assume full ultimate financial responsibility for the operations of nuclear power stations (unlike other sources of energy supply and industrial sectors generally), so that this is normally underwritten by the state. Similarly, private investors have in the past not been prepared to incur the risks associated with exclusively private construction and operation of nuclear plant. The Government review in 1995 concluded that "private finance for a new nuclear station is unlikely to be forthcoming in current conditions without a transfer of specific risks away from private investors to another party in the project" (p.23). The only conceivable 'other party' in this context would seem to be the Government, meaning that the taxpayer is the ultimate bearer of these risks. It is unlikely that this situation has changed since 1995, or will do so in the future. It would seem essential for good policy making that any future 'transfer of risks' of this kind be accompanied by an absolutely transparent specification of the risks involved, and subject to explicit public acceptance of the transfer, the more so as such transparency and public acceptability have not been features of such decision making in the past (which is one of the reasons for public wariness of nuclear power).

6.2.3 Security of Supply

Fears about long-term security of supply are one of the reasons for the Government's Energy Policy Review. Insecurity of supply is a cost and should be considered as such, (even if a price cannot be put in it). Different energy sources are subject to very different security considerations. Fossil fuels are subject to price volatility, depletion and possible geopolitical constraints. Nuclear fuel has to be imported, but can be obtained from a more diverse group of countries than fossil fuels, and has the advantage (once the power station is built) of large-scale, steady generation, which conforms well with the current configuration and characteristics of the electricity supply network. However, the large scale of nuclear plants is a disadvantage in relation to security of supply when they malfunction and have to be shut down for a period (because the grid then loses a large chunk of capacity all at once). Furthermore, if the evolution of energy supply technologies tends to favour smaller scale, more decentralised energy sources (such as, most obviously, renewables), then continued reliance on nuclear power may inhibit the development of the different kinds of networks which will be necessary to use these sources to best advantage.

6.2.4 Public Acceptability

There is general agreement that nuclear power (along with some other energy sources) has a problem with public acceptability (this issue is addressed in both NEA 2000 and RAC/RS 1999). Increasingly even advocates of nuclear energy recognise that this problem cannot simply be dismissed as due to ignorance or irrationality about scientific 'facts', to be tackled simply by more intensive, one-way communication of these 'facts' about nuclear power. Rather it is clear that these 'facts' are contested and will have to be clearly and openly presented and argued for, against other interpretations of reality about nuclear power which are certain to be forcefully put by those who do not share the nuclear industry's, or other nuclear advocates', viewpoint on the issue. In the past, the nuclear industry has not been good at the kind of open and transparent public dialogue that builds trust and credibility. It would seem to be a major pre-requisite of winning the public support that a new nuclear programme in the UK will need for the nuclear industry to improve its performance in this regard.

References

ACEA (2000), *Monitoring of ACEA commitment on CO_2 emission reduction from passenger cars*, a joint report of ACEA and the European Commission, Brussels.

ACCPE (2000), *Choosing Green: Towards More Sustainable Goods and Service*, First Report of the Advisory Committee on Consumer Products and the Environment, Stationery Office, London

Baldwin & Yates (1998), *BREEAM 98 for offices: an environmental assessment for office buildings*, Building Research Establishment, Garston.

Barker, T. & J. Kohler (Eds) (1998), *International Competitiveness and Environmental Policies*, Edward Elgar, Cheltenham.

Bathurst, G. and G. Strbac, 2001. 'The value of intermittent renewable sources in the first week of NETA', *Tyndall Briefing Note No.2*, 3rd April, Tyndall Centre for Climate Change Research, University of East Anglia.

Boardman, B. et al (1997), *DECADE: 2MtC*, Energy & Environment Program, Environmental Change Unit, University of Oxford.

Boardman, B (1998), 'Energy, efficiency and equity', Melchett Lecture, Institute of Energy, London.

Bordass, B. & R. Bunn et al (1999), 'The PROBE project: technical lessons from PROBE 2', paper presented at *Engineering in the 21st century-the changing world*, National Conference, Harrogate, October.

Brechling, V. D. Helm & S. Smith (1991), 'Domestic energy conservation: environmental objectives and market failures', in D. Helm (eds) *Economic Policy towards the Environment*, Basil Blackwell Ltd., Oxford.

CEC (Commission of the European Communities) (2001), *Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings*, COM (2001) 226 final, Brussels.

Chesshire, J. (ed) (2000), *From electricity supply to energy services: prospects for active energy services in the EU*, European Commission & Euroelectric, Brussels.

Consumers Association (1999), *Energy efficiency: warm homes, low bills, cool planet*, London.

Department of the Environment (1991), *English House Condition Survey 1991*, Energy Report, HMSO, London.

DETR (Department of the Environment Transport & the Regions) (2000a), *Climate Change: the UK Programme*, HMSO, London.

DETR (Department of the Environment Transport & the Regions) (2000c), *The UK Fuel Poverty Strategy*, HMSO, London.

DETR (Department of the Environment, Transport and the Regions) (2001a), *Achieving a Better Quality of Life: Review of Progress Towards Sustainable Development*, Government Annual Report 2000, DETR, London.

DETR (Department of the Environment, Transport and the Regions) (2001b), *UK Fuel Poverty Strategy*, Consultation Draft, February, DETR, London.

DETR (Department of the Environment, Transport and the Regions) (2000b), *Energy Efficiency Commitment 2002-2005 (Formerly EESOP4): the Government's Provisional Conclusions*, November, DETR, London.

DETR (Department of the Environment, Transport and the Regions) (1999), *Fuel Poverty: the New HEES – a programme for warmer, healthier homes*, May, DETR, London.

DoE & DTp (Department of the Environment & Department of Transport) (1992), *Reducing transport emissions through planning*, HMSO, London.

DTI (Department for Trade & Industry) (2000d), *Energy services in the UK domestic sector: barriers to development and recommended action plan*, HMSO, London.

DTI (Department for Trade & Industry) (2000e), *New and renewable energy. Prospects for the 21st Century. The Renewables Obligation preliminary consultation*, October, DTI, London.

DTI (Department for Trade & Industry) (2001a), *DTI initial contribution to the PIU energy review*, DTI, London.

DTI (Department for Trade & Industry) (2001b), *New and renewable energy for the 21st Century. The Renewables Obligation statutory consultation*, DTI, London. Available at: http://www.dti.gov.uk/renewable/pdf/energymaster.pdf

DTI (Department for Trade and Industry) (1999), *New & Renewable Energy: Prospects for the 21st Century, Supporting Analysis*, March, Report R-122 produced by ETSU for the DTI, DTI, London.

DTI (Department for Trade and Industry) (2000a), *The Energy Report*, available on www.dti.gov.uk/EPA/bluebook/index.htm

DTI (Department for Trade and Industry) (2000b), *Energy Projections for the UK*, Energy Paper 68, DTI, London.

DTI (Department for Trade and Industry) (2000c), *Digest of UK Energy Statistics*, The Stationery Office, London.

Egan, J. (1998), *Rethinking Construction. The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction,* Department of Environment, Transport and the Regions, HMSO, London.

EGWG (Embedded Generation Working Group) (2001), *Embedded Generation Working Group Report*, DTI, London. Available at: http://www.dti.gov.uk/energy/egwg/report.htm

Ekins, P. (1999), 'Environmental taxation, equity and competitiveness' A paper for the Government's Round Table on Sustainable Development, Warwick University, June 25.

Ekins, P. (2001), *The UK's Transition to a Low-Carbon Economy,* Policy Briefing PB5/01, Forum for the Future, London.

Ekins, P., R. Cotton, A. Russell & C. Hargreaves (2001), *Sustainable energy for the UK: the economic and environmental implications to 2020 of a sustainable energy strategy for the UK*, Technical Report at TR5/01, Forum for the Future, London.

ENDS (Environmental Data Services) (1999), 'Ministers look towards regional renewable energy targets', *ENDS Report*, Issue 298, November.

ENDS (Environmental Data Services) (2001), 'Shell's continued renewables investment', *ENDS Report*, Issue 317, June.

ENDS (Environmental Data Services) (2001b), 'Regional renewables assessments leave national targets in balance', *ENDS Report*, Issue 316, May.

Energy Technology Support Unit (ETSU) 1997 Assessment of CHP Potential, Final Report to the DETR, Harwell.

FFF (Forum for the Future: author Ekins, P.) (2001a), *The UK's Transition to a Low-Carbon Economy*, Policy Briefing PB5/01, Forum for the Future, London.

FFF (Forum for the Future: authors Ekins, P., Cotton, R., Russell, A. & Hargreaves, C.) (2001b), *Sustainable Energy for the UK: the Economic and Environmental Implications to 2020 of a Sustainable Energy Strategy for the UK*, Technical Report TR5/01, Forum for the Future, London.

Green Alliance (2001), *Institutional design for a low-carbon economy*, Green Alliance, London.

Grimston, M. & Beck, P. (2000) *Civil Nuclear Energy: Fuel of the Future or Relic of the Past?*, Royal Institute of International Affairs, London.

Hartnell, G. (2001), *Planning and renewables: implications for meeting the targets*, Paper presented at the CREA Conference on Regional Planning Targets: rationale, progress and practical implementation, 22nd March, 2001.

Hertin, J., Randall, T., Watson, J. and C. Gough (2001), *Renewable energy and Combined Heat and Power resources in the UK*, SPRU working report, Brighton.

HMG (Her Majesty's Government) (1995), *The Prospects for Nuclear Power in the UK: Conclusions of the Government's Nuclear Review*, May, Cm2860, HMSO, London.

Hughes, T.P. (1987), 'The evolution of large technological systems', in Bijker, W.E., Hughes, T.P. and T.J. Pinch, *The Social Construction of Technological Systems; New Directions in the Sociology and History of Technology*, MIT Press, Cambridge, M.A.

Intergovernmental Panel on Climate Change (2001), *Working Group III Third Assessment Report*, Cambridge University Press, Cambridge.

Johnson, P, S. McKay & S. Smith (1990), *The Distributional Consequences of Environmental Taxes*, IFS Commentary No. 23, Institute for Fiscal Studies, London.

Lovins, A.B. & L.H. Lovins (1997), *Climate: making sense and making money*, Rocky Mountain Institute, Colorado.

MacKerron, G. (1995), 'The politics and economics of decommissioning', Paper presented at the 4th international conference on decommissioning of nuclear facilities, London 14-15 February 1995, IBC Technical Services, London.

McLaren, D. (1993), 'Compact or dispersed: dilution is no solution', *Built Environment*, 18 (4), pp 268-84.

NEA (Nuclear Energy Agency) (2000), *Nuclear Energy in a Sustainable Development Perspective*, NEA/OECD, Paris. Available on: www.nea.fr/html/ndd/docs/2000/nddsustdev.pdf

New Energy (2001), *Statistics*, Issue, No.4, August.

Newman, P. & J. Kenworth (1989), *Cities and automobile dependence*, Gower Technical, Aldershot.

OFGEM (Office of Gas and Electricity Markets) (2001), *Report to the DTI of the initial impact of NETA on smaller generators*. Available at: www.ofgem.gov.uk/docs2001/52_small_gens_review.pdf

OFGEM (Office of Gas and Electricity Markets) (2001b), *Review of the NETA and the impact on smaller generators*. Available at: www.ofgem.gov.uk/docs2001/summary_neta_review.pdf

PIU (Performance and Innovation Unit) (2001a), Scoping Note available on www.cabinet-office.gov.uk/innovation/2001/energy/energyscope.shtml

PIU (Policy Innovation Unit) (2001b), *Energy Productivity*, Working paper from PIU project on Resource Productivity and Renewable Energy, available on http:www:cabinet-office.gov.uk/innovation/2001/resource/agpaper.shtml

Power, A. & K. Mumford (1999), *The Slow Death of Great Cities? Urban abandonment or urban renaissance*, Joseph Rowntree Foundation.

RAC/RS (The Royal Academy of Engineering/The Royal Society) (1999), *Nuclear Energy: The Future Climate*, June, RAC/RS, London.

RCEP (Royal Commission on Environmental Pollution) (1994), *Transport and the Environment*, Eighteenth Report, HMSO, London.

RCEP (Royal Commission on Environmental Pollution) (2000), *Energy – the Changing Climate*, 22^{nd} Report of the Royal Commission of Environmental Pollution, The Stationery Office, London.

Robinson, J.B. (1991), 'The proof of the pudding: Making energy efficiency work', *Energy Policy*, September, pp 631-645.

Romm, J.J. (1999), *Cool Companies: how the best instances boost profits and productivity by cutting greenhouse gas emissions*, Island Press, Washington D.C.

Royal Dutch/Shell (2001), *Annual report and accounts, 2000*. Available at: http://www.shell.com/downloads/publications/51579.pdf

Schipper, L., S. Meyers and R. Howarth (1992), *Energy efficiency and human activity: past trends, future prospects*, Cambridge University Press, Cambridge.

Scrase, I. (2001), *White collar CO_2: energy consumption in the service sector,* Association for the Conservation of Energy, London.

Shove, E., Lutzenheiser, L., Guy, S. Hackett, B. and H. Wilhite, 1998. Energy and social systems, in Rayner, S. and E.L. Malone (eds) Human Choice and Climate Change, Battelle Press, Columbus, Ohio.

Sorrell, S (2000), Barriers to energy efficiency in the UK mechanical engineering sector, a report to DG Research under the JOULE project 'Barriers to energy efficiency in public and private organisations', SPRU, October.

Sorrell, S. (2001),'Making the link: climate policy and the reform of the UK construction industry', *Energy Policy*, forthcoming.

Sorrell, S., J. Schleich, S. Scott, E. O'Malley, F. Trace, U. Boede, F. Trace, K. Ostertag, P. Radgen, (2000), *Barriers to Energy Efficiency in Public And Private Organisations*, Final report to DG Research under the project Barriers to Energy Efficiency in Public And Private Organisations. SPRU (Science & Technology Policy), University of Sussex, Brighton.

Steadman, P. & M. Barrett (1990), *The potential role of town & country planning in reducing carbon dioxide emissions,* a report to the Department of the Environment, Earth Resources Research.

Thomas, S., MacKerron, G. & Surrey, J. (1994) 'Sustainability and Nuclear Plant Decommissioning', Proceedings of the International Symposium 'Models of Sustainable Development: Exclusive or Complementary Approaches of Sustainability?', Vol.1, pp.547-556, C3ED, Université de Versailles, or available in mimeo from SPRU, University of Sussex

UK Round Table on Sustainable Development (2000), *Not too difficult! - economic instruments to promote sustainable development within a modernized economy*, London.