Sustainable
Development Commission

forging an energy policy for sustainable development

A paper for the energy policy review of the UK government

October 2001

Contents

PART 1

Contents

PART 2

See separate contents at start of part 2

Executive Summary

The Performance and Innovation Unit (PIU) of the Cabinet Office is currently engaged in an Energy Policy Review, for which this paper is a submission from the Sustainable Development Commission. The Review is focusing on the issues of diversity and security of energy supply, of meeting environmental objectives, especially in respect of large cuts in carbon emissions, and of managing the potentially conflicting economic and environmental policy goals for energy prices.

The Commission believes that sustainable development should be the central organising principle guiding policy choices on all issues and at all levels of government. For the purposes of this exercise we have derived six more specific criteria of sustainable development for energy policy, as follows:

- integrating the economic, social and environmental dimensions of quality of life
- respecting biophysical limits
- making the polluter pay
- protecting and enhancing UK competitiveness
- promoting social justice and inclusion
- achieving energy security.

In Part 1 of this paper we assess current energy policy, and three of the major low-carbon energy options for the UK – energy efficiency, renewables and nuclear power – against these criteria. The assessment draws on the detailed policy analysis which is in Part 2 of the paper. Our conclusion is that a combination of energy efficiency and new renewable energy sources performs strongly against all the sustainable development criteria and is the first choice when it comes to meeting the energy demand and supply challenges of the future in a manner consistent with sustainable development. The building of new nuclear power stations performs substantially less strongly against the sustainable development criteria used. To promote sustainable development, therefore, Government should concentrate its policies and resources on increasing energy efficiency and developing and deploying renewable energy technologies.

From Part 2 of the paper it is clear that, despite current Government policies and targets for energy efficiency and renewables, important barriers to their widespread implementation remain. The targets will be met, and further emission reductions achieved, only if the policies are extended and intensified, and an appropriate institutional framework is put in place, to manage the whole development of the UK energy system – including power generation, industry, households and transport – in an integrated, co-ordinated and consistent way. Recommendations follow as to the kinds of policies and other initiatives which the Commission believes to be necessary to achieve this.

The Commission is persuaded that, if these recommendations are followed, energy efficiency and renewables have ample technical and economic potential to put the UK economy on a low-carbon trajectory without harming its competitiveness and to satisfy the demand of UK citizens for energy services. The building of new nuclear stations should not be necessary to meet these objectives, and may only be perceived to become so if Government fails to realise the potential of energy efficiency and renewables. The Commission strongly expects the Government, in line with its commitment to sustainable development, to ensure that this does not happen.

Recommendations

Energy Efficiency

• Much more ambitious energy efficiency measures than those in the Climate Change Programme (CEP) 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.

Efficiency Potential and the Rationale for Intervention

• Energy efficiency scores highly against each of the sustainable development criteria and can simultaneously meet economic, environmental and social objectives. The Energy Policy Review should therefore give equal weight to issues of energy demand and energy supply. This will help redress the lack of attention to energy demand issues that has characterised energy policy to date.

• Evidence suggests that energy demand could be reduced by as much as a third through investments that are cost effective at current energy prices. However, 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. 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.

• Internalising the environmental costs of energy use in energy prices will increase the cost effective potential and stimulate technical innovation and will be essential for the achievement of a transition to a low carbon economy. 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.

Policies for Industry

• The Climate Change Levy (CCL) and negotiated agreements represent the most important developments in UK energy efficiency policy since the 1970's, but have led to an over-complex policy mix. This could be resolved by making it clear that the negotiated agreements are 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.

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.

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 in energy efficiency, and the poor quality of the UK housing stock contributes to widespread fuel poverty. The initiatives in the CCP do not address these problems to an adequate extent. 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.

Policies for the Transport Sector

- Transport provides the greatest challenge to the transition to a low carbon economy. 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.

- Long-term policy must simultaneously encourage alternative fuels, reduce energy intensity, promote modal shifts and reduce the need to travel, including through land use planning. Energy considerations need to be integrated into all aspects of transport decision-making.

Renewables

- 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.

- Both the Government's 2010 target of 10% electricity generation from renewables, and the renewables scenario to 2050 set out by the Royal Commission on Environmental Pollution (RCEP), imply unprecedented rates of growth from these technologies. However, 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.

- The Renewables Obligation (RO) 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.

Policy Impacts and Institutional Implications

- 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.

- Energy systems generally are now at a potential historical turning point, driven as much by technological changes as by environmental or other considerations, where they could either become consolidated in a centralised form following most of the experience of the last century, or begin a long-term process of decentralisation and dispersion in favour of more locally based forms of power generation, in particular. The UK is currently ill prepared for this latter possibility. The PIU Energy Policy Review should take the opportunity of showing how it could remedy this situation.

1. Introduction

The role of the Sustainable Development Commission (SDC) is to advocate sustainable development across all sectors in the UK, review progress towards it, and build consensus on the actions needed if further progress is to be achieved. Our strategic objectives are:

- To advocate a compelling vision of a sustainable economy and society
- To review how far sustainable development is being achieved in the UK across all sectors.
- To identify the opportunities for, and obstacles to, step changes for sustainability by government, business and the media.
- To promote mechanisms which will deliver a sustainable society.
- To advance innovative approaches to policy making and encourage wider participation.
- To mainstream the principles and practices of sustainable development and to support and encourage leadership and best practice in all sectors of society.

This paper is based on work carried out for the Commission by Professor Paul Ekins of the Policy Studies Institute and Dr Adrian Smith and Steven Sorrell of SPRU, Sussex University. It first of all sets out, in the next section, what the Commission understands by sustainable development, in terms of both broad principles and some more specific criteria against which Government policies and practices may be evaluated. It then assesses in section 3 the broad thrust of current energy policies against these criteria and draws some conclusions as to how these policies should be changed, in general terms, in order to be consistent with sustainable development principles and to contribute to it more effectively in practice.

Section 4 contains sustainable development assessments of energy efficiency, renewable energy sources and nuclear power, which are the major options for reducing carbon emissions available to the UK. This section should be read in conjunction with Part 2, which considers the policy options in respect of energy efficiency and renewables in some detail, in the context of the Government's carbon reduction targets to 2010 and the recommendation from the Royal Commission on Environmental Pollution (RCEP) that the UK should seek to reduce its carbon emissions by 60% by 2050. Part 2 also sets out some of the issues relevant to nuclear power and sustainable development. And it identifies issues which need to be addressed and offers possible ways forward.

The final section of Part 1 draws out some broad conclusions and recommendations about the nature and shape of an energy policy that will promote sustainable development. The Commission will, in due course, evaluate the conclusions and recommendations of the Government's Energy Policy Review against its own.

2. Principles of Sustainable Development

The extensive work carried out by policy makers and others over the last ten years has resulted in the definition and clarification of the concept of sustainable development, such that there is now broad agreement that sustainable development is a process that exhibits the following characteristics:

- It enables people, now and in the future, to satisfy their basic needs, especially with regard to those people who are presently furthest from such satisfaction.

- It enables people, now and in the future, progressively to realise their potential and improve their quality of life, which is recognised to have economic, social and environmental dimensions.

- It protects and enhances the Earth's life-support systems, now and in the future, especially those which are fundamental to basic needs satisfaction and human quality of life.

At root, therefore, sustainable development is a process which seeks to ensure that the fruits of development are both widely shared across the current generation, and generated in such a way that future generations have at least the same development opportunities as exist at present, especially in respect of the environment and natural resources.

On the basis of such considerations, the Government has adopted four over-arching objectives of sustainable development:

- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources; and
- Maintenance of high and stable levels of economic growth and employment.

The Government considers that sustainable development requires that these four objectives be met at the same time.

The Commission notes that it is a radical departure for public policy to place environment and resource objectives at the same level of policy priority as economic (especially) and social objectives. It is to be hoped that this broadening of objectives will reveal many instances, hitherto overlooked, in which economic, social and environmental goals can be simultaneously pursued and achieved. The Commission is enthusiastic about this possibility and will always seek in its conclusions and recommendations to identify and promote such desirable outcomes. This integration of economic, social and environmental objectives will be one of the hallmarks by which sustainable development policies will be recognised and through which sustainable development will be achieved.

However, political realities suggest that the mere adoption of environmental alongside economic and social objectives will not enable all three sets of objectives to be achieved, for everyone, all of the time. Very difficult decisions about winners and losers, now and in the future, will remain. In particular, there will be times in the future when social and economic priorities will conflict with respect for environmental limits, as they have in the past. The Commission considers that, unless significantly more decisions in such cases are taken in favour of the environment than has hitherto been the case, and the necessary adjustments are made to economic and social objectives, there is little prospect of the reality of 'sustainable development' differing much from its unsustainable predecessor. In essence this means not just integrating environmental, economic and social dimensions of sustainable development into all policy processes, but of striking the balance between them in such a way that the environmental dimension is given substantially increased weight.

In order to pursue the objectives of sustainable development it is helpful to have some guiding principles and approaches. Those put forward by the Government are set out in Box 2.1.

It is clear that these principles still leave plenty of room for different interpretations of many of the key ideas which they embody, and therefore for different policy conclusions based on them. There will still be many difficult and contested decisions to be taken in respect of, for example:

- Sharing economic and environmental resources within and between different generations of people.
- Arguing for long-term sustainable development objectives even when they conflict with other short-term aspirations.
- Seeking to ensure that the aspirations of some people for an enhanced quality of life through increased consumption do not reduce the life opportunities of others, now and in the future.
- Defining the environmental limits which should not be breached.
- Deciding when to invoke the precautionary principle.
- Calculating how much polluters (consumers) should pay, and persuading or legislating for them to pay it, consistent with ability to pay and other considerations of social justice.

If much of development in the past has been unsustainable it is because policy makers have either not considered, or have shied away from, these difficult issues, for reasons which may be politically understandable but which, for the long-term public good, can no longer be allowed to be the main determinants of policy.

Box 2.1 UK Government: Guiding principles and approaches to sustainable development

Putting people at the centre. Sustainable development must enable people to enjoy a better quality of life, now and in the future. In the words of the *Rio Declaration*, 'human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Taking a long-term perspective. Sustainable development thinking cannot restrict itself to the life of a Parliament, or the next decade. Radical improvements have to begin now to safeguard the interests of future generations. At the same time we must meet today's needs — for example, people need warm homes, which, at present, means using predominantly fossil fuels.

Taking account of costs and benefits. Decisions must take account of a wide range of costs and benefits, including those which cannot easily be valued in money terms. In pursuing any single objective, we should not impose disproportionate costs elsewhere. Public values, the timing of costs and benefits and risks and uncertainties should be taken into account.

Creating an open and supportive economic system. Sustainable development requires a global economic system which supports economic growth in all countries. We need to create conditions in which trade can flourish and competitiveness can act as a stimulus for growth and greater resource efficiency.

Combating poverty and social exclusion. Eradicating poverty is indispensable for sustainable development. We must help developing countries to tackle widespread abject poverty. In this country, everyone should have the opportunity to fulfil their potential, through access to high quality public services, education and employment opportunities, decent housing and good local environments.

Respecting environmental limits. Serious or irreversible damage to some aspects of the environment and resources would pose a severe threat to global society. Examples are major climate change, overuse of freshwater resources, or collapse of globally significant fish stocks. In these cases, there are likely to be limits which should not be breached. Defining such limits is difficult, so precautionary action needs to be considered.

The precautionary principle. The *Rio Declaration* defines the precautionary principle as 'where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'. Precautionary action requires assessment of the costs and benefits of action, and transparency in decision-making.

Using scientific knowledge. When taking decisions, it is important to anticipate early on where scientific advice or research is needed, and to identify sources of information of high calibre. Where possible, evidence should be reviewed from a wide-ranging set of viewpoints.

Transparency, information, participation and access to justice. Opportunities for access to information, participation in decision-making, and access to justice should be available to all.

Making the polluter pay. Much environmental pollution, resource depletion and social cost occur because those responsible are not those who bear the consequence. If the polluter, or ultimately the consumer, is made to pay for those costs, that gives incentives to reduce harm, and means that costs do not fall on society at large. At the same time, it may not always be possible for everyone to bear all such costs, particularly for essential goods and services.

Source: DETR 2001, p.19

The Commission believes that sustainable development should be the central organising principle guiding policy choices on all issues and at all levels of government. Within this overall approach, the Commission is developing its own set of sustainable development principles and criteria against which it will evaluate Government policy and practice. As an interim measure, and for the purposes of the current exercise only, we have devised the set of criteria set out below (Box 2.2).

Box 2.2 SDC criteria for judging energy policies for their contribution to sustainable development

***Integrating the economic, social and environmental dimensions of quality of life*:** have all these dimensions been explicitly considered in such a way as to exploit any synergies, and avoid any trade-offs, between them wherever possible?

***Respecting biophysical limits*:** where the policies are not designed actually to benefit the environment, do they at least ensure that the environment is protected and resources used in such a way that serious or irreversible environmental damage is avoided, potentially dangerous thresholds of environmental impact are not exceeded and important environmental functions are maintained for future generations to enjoy?

***Making the polluter pay*:** do the policies seek to ensure, where relevant, that environmental costs are progressively internalised into the activities responsible for them, and that incentives progressively encourage more environmentally sustainable behaviour and discourage the reverse?

***Protecting and enhancing UK competitiveness*:** where the policies are not explicitly designed to promote it, have the impacts of the policies on the competitiveness of the UK economy as a whole been evaluated, and the policies formulated to make these impacts as positive as possible? Where the impacts are potentially negative, have counter-measures been put in place to avoid this?

***Promoting social justice and inclusion*:** do the policies contain measures which enable those currently excluded from important aspects of economic and social life (such as employment) to gain access to or play a fuller part in them? And do they enable all of us to have more control over those elements which affect our lives most directly?

***Achieving energy security*:** do the policies ensure that the UK's essential needs for energy are securely met, in terms of security of access, distribution and supply, and in terms of vulnerability to accident or attack?

It is with these criteria in mind that the Commission proceeds to evaluate current energy policy.

3. Current UK Energy Policy and Sustainable Development

3.1 Background

UK energy policy has gone through many permutations in the last forty years, in response to both changes in prevailing policy approaches and external events. The 1960s were characterised by cheap oil and the early, optimistic development of nuclear power. They were uncomplicated years in energy terms, which were brought abruptly to an end in the 1970s by the OPEC price rises, the emergence of environmental opposition to nuclear power, and the Three Mile Island nuclear accident in 1979.

The 1980s saw the UK emerge as a major oil producer, with the industry surviving an oil price which fell as abruptly in mid-decade as it had risen in the 1970s. The development of UK nuclear power was halted by a combination of excessive costs and public concern, heightened by the Chernobyl accident, which was reflected in enormously extended public inquiries. UK coal production went into long-term decline.

Towards the end of the decade the privatisation of the energy utilities and the liberalisation of energy markets got under way, and these were to prove the dominant UK energy themes of the 1990s. The UK enjoyed broad energy self-sufficiency in fossil fuels, the prices of which for businesses and households stayed low or fell. Gas replaced coal as the major fuel for power generation. Public support for the construction of new nuclear power plants was temporarily ruled out by the Government's nuclear review in 1995 (HMG, 1995), and the first significant public support for the market development of renewable energy sources was expressed through the Non-Fossil Fuel Obligation (NFFO). Such support was, however, exceptional and very much against the main grain of energy policy in this decade, which was broadly to leave decisions to the energy markets, with these being regulated where it was perceived that competition was not yet adequately developed. More recently a number of longer-term programmes were developed and then adopted in areas related to energy, most notably the Climate Change Programme (CCP, DETR, 2000a) and the Fuel Poverty Strategy (DETR, 2001b). While the CCP envisaged that significant cuts in CO_2 emissions from 1990 levels could be achieved by 2010, emissions were projected to rise again thereafter, partly as a consequence of the closure of nuclear power stations. This raised serious questions about the feasibility of the 60% cut in carbon emissions by 2050, as proposed in the twenty-second report of the RCEP, *Energy - the Changing Climate* (RCEP, 2000).

Towards the end of the decade it became clear that UK oil and gas production would decline in the following decade, leaving the UK once more a significant importer of oil and gas. By 2020 the great majority of these fuels would need to come from other countries. Their supply will also be increasingly geographically concentrated in OPEC countries or in countries with a recent history of political instability.

In June 2001, soon after the last General Election, the Government initiated an Energy Policy Review, to be conducted by the Cabinet Office's Performance and Innovation Unit (PIU). The Scoping Note of the

Review (PIU, 2001a) defines the three key challenges which the Review seeks to address as:

- ***Managing potential conflict with environmental objectives***. Meeting the long term targets for emissions reductions, whilst ensuring future projections for energy demand are met, will require fundamental changes in energy and fuel markets, the management of energy demand, the development of new technologies, and infrastructure and policy;

- ***Ensuring continued security and diversity of energy supplies over the long term*** including ensuring appropriate investment incentives to maintain sufficient spare capacity to be able to cope with supply shocks, especially within the regulatory regimes for the energy utilities; and

- ***Managing potentially conflicting policy goals for energy prices***. Higher energy prices could be a potent instrument for advancing environmental objectives but they are in potential conflict with fuel poverty and industrial competitiveness objectives. The relevance of these challenges to sustainable development is clear. The next section describes how current energy policy is seeking to respond to those challenges. Section 3.3 assesses this current policy in relation to the sustainable development criteria set out earlier.

3.2 Current Energy Policy

The Government describes its overall energy policy objective as "ensuring secure, diverse and sustainable supplies of energy at competitive prices" (DTI, 2000a, p.4), and envisages that competitive energy markets have a key role to play in achieving this objective. A major proportion of its energy policy efforts in the last two years has focused on bringing into force the Utilities Act 2000, which is mainly concerned with the creation, operation and regulation of gas and electricity markets, including provisions to ensure that social and environmental considerations can be taken into account.

Annex 1 of the PIU Scoping Note gives some basic facts about current UK energy use and projections, selections from which are given here with other relevant information for convenience. Primary energy use in the UK over the past two decades has risen steadily (at a rate of over 0.5% pa), though well below the trend rate of growth of GDP (of 2.5%). Within this, the contribution of different energy sources has changed considerably. Over the last two decades, coal's share has halved whilst that of gas has almost doubled. These trends are expected to continue over the next two decades, with nuclear power's share falling (as nuclear power plants are decommissioned) and renewable energy taking a modestly increasing share. By 2020, on current policies, nearly half of the UK's energy needs will be met by gas with coal accounting for just over 6%, renewables 4% and nuclear power 3%. The balance will be met by oil which accounts for a steady 35-40% of UK energy demand throughout the period.

The three major energy-using sectors are industry, households and transport. The main sectoral trends here are the substantial growth in energy consumption accounted for by transport and the more modest growth in the domestic sector (due both to increasing household numbers and increasing demand for energy in the home) and steady or declining energy consumption by industry.

UK CO_2 emissions come from four main sources: power stations (26% of 1998 emissions), industry, commerce and public administration (31%), transport (22%) and households (14%). The balance of 7% comes from land use change, forestry, military sources, and various fugitive emissions (DTI 2000c, p.252). A comparison between trends in primary energy consumption in the UK with trends in CO_2 emissions by fuel highlights the benefits of the switch from coal to gas in reducing CO_2 emissions but, by 2010, CO_2 emissions are projected to rise again as energy demand continues to increase and as nuclear's share falls. Data on trends in energy prices set out in Table 3.1 show that, compared with the price of other goods and services in the economy, energy prices have in general fallen considerably in real terms. This is partly because of favourable circumstances in global energy markets (e.g. low oil prices, at least until recently) and partly because of privatisation and the regulatory regime created for the energy utilities. Post-tax petrol prices are the exception to this picture of generally falling energy prices in recent decades – Table 3.1 shows that they increased by 44% in real terms between 1990 and 2000.

Table 3.1: Trends in Real UK Energy Prices by Fuel, 1990 – 2000 (1990 = 100)

	1990	**1995**	**1999**	**2000**
Domestic Sector				
Coal	100	100.6	94.8	94.7
Oil	100	75.7	68.0	93.7
Gas	100	94.7	80.5	77.2
Electricity	100	101.7	81.6	78.1
Industrial Sector				
Coal	100	73.1	60.6	59.9
Oil	100	95.8	85.2	126.3
Gas	100	76.1	55.0	58.6
Electricity	100	91.8	73.8	67.8
Transport				
Petrol	100	110.4	129.7	144.1

Source: PIU 2001, Annex 1, Table 4

The PIU Scoping Note splits current Government energy policies into two main areas:

1. Policies to improve the security and diversity of energy supplies:

- measures to promote energy efficiency and renewables;
- clean coal technology initiatives;
- reform of the operation of the electricity market to remove distortions which encouraged investment in gas-fired power generation at the expense of existing coal fired plant;
- a temporary policy of stricter consents for new gas-fired power stations from end 1998 to end 2000, followed by a short term subsidy for the UK coal industry, 2000/01-2001/02;
- the energy regulatory framework and its role in promoting competitive markets;
- a joint government/industry effort through PILOT to increase UK oil and gas production;

- promotion of greener transport fuels, including renewable biofuels.

2. *Policies to lessen the environmental impacts of energy consumption:*

- the UK Climate Change Programme to meet the UK's Kyoto target and move towards the domestic carbon dioxide goal (both described further below). Some of the key measures include:
- implementation of the Kyoto Protocol of the UN Framework Convention on Climate Change;
- a target for renewable energy of 10% of electricity generation by 2010;
- the renewables R & D programme;
- a target for Combined Heat and Power (CHP) of 10 GWe capacity by 2010;
- support for the Energy Saving Trust and the establishment of the Energy Efficiency Commitment, and other measures to improve energy efficiency and tackle fuel poverty in the domestic sector;
- the Climate Change Levy (CCL) and associated agreements to improve energy efficiency in energy-intensive sectors;
- establishment of a UK emissions trading scheme;
- the new Carbon Trust;
- enhanced capital allowances for energy saving products;
- the 10 Year Transport Plan and promotion of alternative fuelled vehicles.

It can be seen that some of the policies (on energy efficiency, renewables, alternative transport fuels) are included in both categories. Many of the policies are complex and several are considered in more detail in Part 2. Here the overall policy mix will be reviewed against the sustainable development criteria developed earlier. Individual policies will be outlined as necessary, and any policy gaps or conflicts briefly noted.

3.3 A Sustainable Development Assessment of Current Energy Policy

It is obvious that access to energy is fundamental to the social and economic dimensions of sustainable development. With regard to the former people need energy for warmth, light and power in their homes, and for mobility. With regard to the latter industry and commerce also need energy for heat, light and power and for transport of the goods they both need and produce. The first point to be emphasised is that the energy services of heat, light, power and transport are not delivered only by energy (fuels), but through *energy systems*, comprising infrastructure (for example, electricity grids and networks, gas supply networks, buildings, roads and railways) and appliances (for example, freezers and washing machines, boilers and fires, light bulbs, and motor cars), as well as fuels. Delivering an energy service efficiently in both economic and environmental terms requires energy policy to address systematically the whole energy system, and not just the fuel supply.

A second initial point concerns the demand for energy. As noted above, and as described in more detail in Part 2, energy demand in both transport and the domestic sector has grown as demand for energy services in these sectors, and household numbers, have grown. Policy approaches in the past that have sought simply to accept and accommodate these demands have proven, especially in respect of road transport, to be unable to deliver the increased level of energy service demanded. For example, with respect to road transport congestion has proved an insurmountable barrier to many of people's aspirations for greater mobility through car ownership and use. Such policy approaches have also resulted in health-damaging levels of pollution and have increased the CO_2 emissions that are the principal cause of climate change. An energy policy that seeks to address these problems, and one that is consistent with the environmental dimension of sustainable development, will need to manage, and sometimes constrain, energy demand.

This is so because all energy technologies are associated with potentially damaging environmental impacts:

- The extraction of fossil fuels can damage landscapes, cause pollution and damage health; their combustion causes air pollution which is the major contributor to respiratory health problems, acid rain and global climate change.

- Nuclear power is associated with actual and potential negative environmental and health impacts at all stages of the nuclear fuel cycle, from the mining of uranium, to the fabrication of the fuel, to radioactive emissions and the risk of accidents during operation, to the disposal of nuclear wastes and the decommissioning of power stations.

- Renewable energy sources are delivered by a variety of technologies, all of which can have negative environmental impacts. Some of the most important are the visual impact and noise associated with onshore wind turbines, the potential ecological impacts of oceanic and tidal technologies, and the transport and agricultural issues associated with energy crops.

The Government's overall energy policy objective of "ensuring secure, diverse and sustainable supplies of energy at competitive prices" deals, therefore, at best with only half the energy policy picture. An overall energy policy objective more in tune with sustainable development might be:
"ensuring that the demand for energy services and the systems through which they are delivered are managed in such a way that the demand can be met by secure and diverse supplies of energy, which are delivered at competitive prices for industry, which are accessible to all households for the satisfaction of their basic needs, and which are produced and consumed in ways that do not damage human health or have serious and irreversible negative effects on the environment."

In practice, as the PIU list of policies above reveals, the Government does have policies that address issues of energy demand and energy systems, as well as energy supply. But the policy as stated runs the risk of treating demand and system issues as an afterthought, or as independent issues, rather than as the fundamental issues for prior consideration, the outcomes of which determine the context for energy supply decisions, rather than the reverse. An example of this is the way the New Electricity Trading Arrangements (NETA) militate against renewables and combined heat and power (CHP), rather than making special provision to promote them, in line with Government policy. This will be discussed further below.

The policies will now be considered against the sustainable development criteria, which were set out above, in turn:

Integrating the economic, social and environmental dimensions of quality of life

- *have all these dimensions been explicitly considered in such a way as to exploit any synergies, and avoid any trade-offs, between them wherever possible?*

As noted above, the Utilities Act 2000, which now sets the framework for much energy policy, did explicitly contain provisions for social and environmental, as well as economic, issues to be considered in energy policy. Indeed, the Secretary of State is currently consulting on the first detailed social and environmental guidance to be given to the energy regulator, OFGEM. In addition, OFGEM has its own Social and Environmental Action Plans. Clearly there will be different views as to whether the guidance is adequately strong, and whether the Action Plans are both adequate in themselves and likely to be implemented adequately. Consideration of this is beyond the scope of this paper, but it is possible to argue that these institutions at least are set up to give due consideration to social and environmental as well as economic issues.

However, this potential for the integration of social, environmental and economic considerations into energy policy has dramatically failed to be realised in practice at the very first occasion when it might have been expected, in NETA, which were implemented in March 2001. The way in which NETA, and associated network connection conditions, have been set up are militating heavily against both renewables generation and CHP, such that an award-winning CHP scheme has stopped electricity exports to the grid, carefully worked out CHP proposals with planning permission have been scrapped, and much renewables capacity is being rendered uneconomic. In addition, most of the wind projects that were awarded contracts under the Government's NFFO5 programme cannot get planning permission. It is astonishing that the Government should have permitted the establishment of a regulatory system that has erected such a barrier to the achievement of two of its key energy targets – more generation from renewables and CHP – in this way. Unless the planning system starts delivering permissions to wind projects, and NETA is swiftly amended to be more favourable to CHP and renewables, the contribution of these sources to the UK energy mix will remain far below their potential – and the Government's targets for 2010.

Equally problematic is the overall institutional structure related to energy and energy policy, which exhibits a worrying degree of fragmentation. This issue is complex, but is discussed in Part 2. It seems important that the Energy Policy Review considers these institutional questions in detail and makes recommendations which will ensure that an appropriate institutional framework is created which can promote sustainable energy use across all sectors and activities.

Respecting biophysical limits

• *where the policies are not designed actually to benefit the environment, do they at least ensure that the environment is protected and resources used in such a way that serious or irreversible environmental damage is avoided, potentially dangerous thresholds of environmental impact are not exceeded and important environmental functions are maintained for future generations to enjoy?*

Historically the use of fossil fuels expanded in a way that paid little attention either to human health or to impacts on the environment. The first of these issues to be addressed was the health impacts of air pollution, such that air quality, especially in cities, is now much improved from a few decades ago. However, unacceptable health impacts from such pollution, especially from road transport, still remain to be addressed. In the 1980s and 1990s the impacts on ecosystems from acid gases from fossil fuel combustion also began to be addressed, such that these impacts are also now much reduced, but, again, there is still further to go before the environment may be said to be protected from 'serious or irreversible damage'. Most recently the focus has turned to climate change. The analysis in Part 2 suggests that, through its CCP, the Government has done much to address this issue, but that its targets for 2010 are by no means sure of achievement. Significant new policies will be required if the UK is to ensure that carbon emissions do not start to increase again after 2010. This is, of course, one of the key challenges being addressed by the Energy Policy Review.

Making the polluter pay

• *do the policies seek to ensure, where relevant, that environmental costs are progressively internalised into the activities responsible for them, and that incentives progressively encourage more environmentally sustainable behaviour and discourage the reverse?*

One of the principal thrusts of current Government policy, as noted above, has been to reduce energy prices through the creation and maintenance of competitive markets. However, since 1997 the Government has also introduced a number of policies to make energy prices more reflective of their environmental costs. Most important in this regard have been the annual increases (inherited from the previous Government) to 1999 in road fuel duties, which have ensured that road fuel prices are unique among fuels in having increased in real terms through the 1990s; and the Climate Change Levy (CCL), implemented in 2001 after lengthy consultation, which applies to the business and commercial use of energy. Other policies have included environment-oriented changes in Vehicle Excise Duty (VED) and the taxation of company cars. These and other policies are discussed in more detail in Part 2.

However, there are a number of areas where current energy policies do not attempt further to internalise environmental costs. These include:

• The treatment of the household use of energy, which has a low (5%) rate of VAT and is exempted from any other energy taxation. The Government's stated reason for this policy is to avoid negative impacts on low-income people, many of whom suffer from fuel poverty. However, the households which benefit most from this exemption are those which use most energy and which generally do not have low incomes and are not in fuel poverty. The energy prices they face give them very little incentive to consider energy efficiency measures or lifestyle changes to conserve energy. A higher rate of taxation of household energy would both increase this incentive and generate financial resources which could be used both to compensate fuel-poor households for the tax increase and to address more vigorously the poor building quality that is responsible for much fuel poverty in the first place. It is hard to see how the Government's policy in this area is consistent with this criterion of sustainable development.

- The cessation in 1999 of the annual increase in road fuel duties and the cuts in road fuel duties, coupled with subsidies to the road haulage industry, implemented in 2000 and 2001. The reasons for these policies were the increases in world oil prices in 1999 and the road fuel tax protests in summer 2000. The freezing of the level of road fuel duty could have been justified in relation to sustainable development if it had been accompanied by a commitment to restart the increases if world energy prices fell. However, no such commitment was given and road fuel taxes have not been increased following recent oil price falls. The tax cuts and subsidies in this area were incompatible with this sustainable development criterion, and represented a political failure to present the increases in road fuel duty as a long-term environmental necessity rather than an opportunity to increase Government revenue by 'stealth'.
- The continuing zero taxation on aviation fuel (the result of complex international treaty obligations) and the failure to make this industry, which is emerging as the most rapidly increasing source of carbon emissions, internalise its environmental costs in other ways. This is a major failure in respect of this criterion of sustainable development, which may or may not be addressed in the White Paper on Aviation which the Government is currently preparing.

Protecting and enhancing UK competitiveness

- *where the policies are not explicitly designed to promote it, have the impacts of the policies on the competitiveness of the UK economy as a whole been evaluated, and the policies formulated to make these impacts as positive as possible? Where the impacts are potentially negative, have counter-measures been put in place to avoid this?*

Probably the strongest strand in current Government energy policy, which was at the heart of the Utilities Act 2000, is its attempts to create and maintain competitive energy markets. There is little doubt that this has contributed to the downward falls in energy prices since 1999 shown in Table 3.1, though with regard to oil and the industrial use of gas (but not yet electricity) these falls have been offset by increases in world prices.

Other things being equal, low industrial energy prices are usually considered to be good for competitiveness. However, expectations of continuing low fossil fuel energy prices have undoubtedly not promoted energy conservation, energy efficiency or alternative no-carbon fuels. This tension between the desirability of low energy prices for competitiveness reasons, and higher prices that internalise environmental costs and give incentives for energy conservation and efficiency, and renewables, is one of the central dilemmas of modern energy policy. It found its most contested expression in the Government's CCL, its tax on the business and commercial use of energy.

The CCL was strongly criticised by business as being harmful to UK industrial competitiveness. To address this the Government has negotiated Climate Change Agreements (CCAs) with 41 industrial sectors, which grant them exemption from 80% of the CCL if they achieve certain carbon reduction targets beyond business-as-usual projections. There have been no suggestions from the sectors concerned that these agreements, and the 20% CCL for which they are still liable, will have significant effects on their competitiveness. Indeed, there is some debate as to whether the CCAs are stringent enough in terms of the carbon reductions they require. Some sectors, which were not eligible for CCAs, have protested that the CCL will have a serious impact on their competitiveness.

The revenues from the CCL are mainly being returned to business through a 0.3% reduction in employers' National Insurance contributions (NICs). This means that many businesses (which have higher labour than energy intensities) are better off, and therefore more competitive, because of the CCL. This is an aspect of the CCL that is very rarely mentioned by business, but which is absolutely critical to the overall effect of the CCL on the UK economy. There are no reasons for thinking that the CCL as implemented will have a negative overall effect on the UK economy. In fact, because the NIC reductions lower the cost of labour to UK business, and may therefore be expected to increase employment, there are good reasons to believe that its overall effect on UK GDP will be small, but positive.

The Government should make clear in situations of this kind that promoting the competitiveness of the UK economy as a whole is very different from seeking to cushion every sector from the effects of environmental policies. Internalising environmental costs will inevitably affect some sectors (those that generate the costs) more than others. What is important is that the most affected sectors are given adequate time and incentives to make the transition towards sustainability, while the rest of the economy is also encouraged to innovate and develop in a way that reduces environmental costs. A tax shift such as the CCL is often an effective way to achieve this.

The CCL/CCA package shows that the Government gave very serious consideration to competitiveness issues in its implementation of the CCL. The judgement of the Commission on this issue is that valid concerns were effectively addressed, though at the cost of formidable policy complexity which is explored in some detail in Part 2.

Promoting social justice and inclusion

- *do the policies contain measures which enable those currently excluded from important aspects of economic and social life (such as employment) to gain access to or play a fuller part in them?Do they enable all of us to have more control over those elements which affect our lives most directly?*

It was noted above that the CCL was implemented in such a way that it was likely to promote employment, by decreasing the cost of labour. It may also be noted that the Government has two major home energy efficiency schemes (the New Home Energy Efficiency Scheme (New HEES) and the Energy Efficiency Commitment) which are oriented towards vulnerable households. Its Fuel Poverty Strategy (DETR, 2001b) commits it to eliminating fuel poverty in these households by 2010. This is an ambitious, but achievable, commitment, which is certainly in accordance with this criterion of sustainable development.

However, this sustainable development criterion goes beyond simply seeking to ensure affordable warmth for vulnerable households, important though this is. It is also concerned with enabling these, and all other, households to participate more in the social choices relating to energy, and to have more influence over the decisions in this area that affect their lives. New technological developments such as local renewables and domestic-scale CHP will offer unprecedented opportunities for more decentralised, community-based energy systems in the future, with large potential savings due to increased energy efficiency and reduced transmission and distribution losses. There is at present very little evidence that the Government is aware of these opportunities, and none that it is actively seeking to promote them. This is a major component of a sustainable energy policy in which the Government needs to make progress in the future.

Achieving energy security

- *do the policies ensure that the UK's essential needs for energy are securely met, in terms of security of access, distribution and supply, and in terms of vulnerability to accident or attack?*

The UK has enjoyed unprecedented energy security over the last twenty years, producing an increasing proportion of its needs for fossil fuels, in which it has been broadly self-sufficient in recent years, and possessing, if anything, excess electricity capacity. There has been no danger in the immediate past of California-style black-outs, nor will there be in the next two decades. There is time to give this area the full consideration it deserves.

As noted above, by 2020 on current forecasts the UK will need to import the great majority of its fossil energy – both oil and gas – which will together meet over 80% of the UK's primary energy demand. This could leave the UK vulnerable to cartel power or political insecurity in other countries.

Because of recent favourable circumstances the Government currently has no policy on energy security. With circumstances changing, it is one of the PIU's key tasks to make recommendations in this area for the future. There are a number of different considerations to take into account:

- The role of energy efficiency and demand-side management. The less energy demand, the less will need to be imported.

- The value of indigenous, non-depletable resources, such as renewables, or those which are at present plentiful and can be imported from many countries, such as uranium.

- The economic and security advantages of large, centralised, predictable sources of electric power, to be set against the considerable back-up sources these also require, in case one or more plants is out of action due to accidents or maintenance, and their vulnerability to attack.

- The economic and security advantages of small-scale, distributed power sources, to be set against the disadvantages of possible loss of economies of scale and, in some case, intermittency of generation.

The PIU will need to consider all these issues in detail. Some of them are discussed further below. However, it is worth noting at this point that at present the structure of the electricity grid effectively rules out extensive distributed power generation. At the very least, in ensuring that its 2010 targets for renewables and CHP are met, the Government must lay the foundations for a much more flexible grid which opens up the option of a largely decentralised electricity supply as a real possibility.

3.4 Conclusions

This very brief evaluation of current UK energy policy against principles and criteria of sustainable development suggests that much has been done to bring energy use more into line with sustainable development, but that certain opportunities to do this have been missed and that, as the Government itself knows, very much more remains to be done.

It is clear that in 2050 it is very likely that fossil fuels will still play an important role even in a low-carbon UK energy system, and that this role would be much enlarged by the development of CO_2 sequestration technologies. However, the focus of this paper is on the three major non-hydrocarbon carbon-reducing options available to the UK – increased energy efficiency, renewables, and nuclear power. In the next sections these are evaluated against the sustainable development criteria employed in the previous section, in order to form a judgement as to which performs best against these criteria and should therefore be favoured in energy policies for sustainable development.

4. Sustainable Development Evaluations of Energy Efficiency, Renewables and Nuclear Power

4.1 Energy Efficiency

Energy efficiency is important for three over-arching reasons. First, increasing energy efficiency 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.

The efficiency of energy use is primarily improved through investment by energy users in new vintages of energy-using technologies. Behavioural change can also play a role in some instances, 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. The focus for most policy is the former.

Policies for energy efficiency are discussed in some detail in Part 2. There now follows an evaluation of energy efficiency using the sustainable development criteria of previous sections.

Integrating the economic, social and environmental dimensions of quality of life

Energy efficiency scores highly on environmental grounds. By providing the same energy service with less energy use, it avoids whatever environmental impacts are associated with energy production and conversion. The marginal benefits will depend on the type of energy being displaced - with electricity for example, we must include consideration of system losses and the fuel mix of displaced generating plant. These environmental benefits are not achieved without environmental costs, as efficiency improvements have environmental impacts associated with the production, use and disposal of the relevant energy-efficient technologies (including embodied energy use). In some cases these impacts will offset the benefits of energy saving, but it is unlikely that this is an important consideration for the majority of relevant technologies.

Energy efficiency can also have substantial economic benefits. As has been repeatedly shown, a large number of efficiency investments are cost effective at current energy prices. Many more would become cost effective if environmental externalities were reflected in energy prices, or if external benefits such as the reduced need for investment in distribution networks could be captured by the investor. Energy efficiency may also improve social conditions for disadvantaged groups such as the fuel poor, at a lower private and social cost than increased energy supply. These multiple benefits do not apply to all technical opportunities to improve efficiency and they do not apply to behavioural change that reduces levels of energy service. But they do apply to a sufficiently large number of cases to make increasing energy efficiency a major means of delivering environmental, economic and social benefits in an integrated way.

Respecting biophysical limits

Use of energy from fossil fuels and nuclear energy sources is associated with serious and potentially irreversible environmental damage, dangerous exceedance of impact thresholds and the disruption of important environmental functions. To the extent that energy efficiency avoids the use of such energy, it makes a positive contribution to respecting such biophysical limits. The caveat is that we must consider the life cycle environmental impacts of the energy-efficient technologies – such as the use of energy, toxic materials or non-renewable resources in manufacture – in order to arrive at an accurate assessment of the net environmental benefits of energy efficiency improvements.

Making the polluter pay

The external environmental costs of energy production and use (including the highly uncertain costs of climate change) cannot be precisely quantified. However, it is clear that substantial rises in the price of fossil fuels would be required to meet targets for atmospheric CO_2 concentrations that are consistent with climate stability. In that sense it may be said that current energy prices do not adequately reflect their external environmental costs. Any cost internalisation that made them do so would make energy efficiency considerably more attractive than it is already. Again, the caveat is the extent to which the life-cycle environmental costs of energy-efficient technologies are also internalised

Protecting and enhancing UK competitiveness

If energy efficiency investments have a high rate of return, then capturing efficiency opportunities should improve the competitiveness of both individual businesses and the national economy. The extent to which this is the case is the subject of ongoing debate. Some economists argue that 'hidden costs', such as management time or production disruptions, make many efficiency opportunities less attractive than they first seem. However, empirical evidence suggests that substantial 'no regrets' opportunities are available, even when hidden costs are taken into account.

Competitiveness should also be considered in the long term. For environmental reasons, there is likely to be increasing pressure to reduce energy demand and carbon emissions. In this context, appropriate energy efficiency investments will enable such pressures to be accommodated at least cost. In addition, there will be increasing export opportunities for manufacturers of energy-efficient equipment, with a corresponding risk of import dependence if UK companies fail to develop low-carbon technologies. Energy efficiency should be a growth industry in a carbon-constrained world.

Promoting social justice and inclusion

Energy efficiency can play a central role in improving the life conditions of the 4.5 million UK households that suffer from fuel poverty. In contrast to winter fuel payments, investment in improving the energy efficiency of such households can simultaneously promote social and environmental goals. In a similar manner, investment in improved bus services can reduce social exclusion and accelerate the transition to a low-carbon transport system.

Energy efficiency is an area which is largely under the control of households. At present few households either consider energy efficiency, or are aware of the opportunities for cost-effective energy efficiency measures. Changing this situation should be an important priority for Government, so that households are enabled to gain more control over their energy use and energy costs.

Achieving energy security

It has already been noted that energy efficiency enhances energy security by reducing the need to import or use energy sources of any kind. Energy efficiency should therefore be the first energy security issue to be addressed, before the security of energy supply is even considered.

Conclusion: energy efficiency

In conclusion, increasing energy efficiency seems very attractive from a sustainable development perspective. It reduces the need for energy supply, of whatever kind, and its associated environmental impacts. The widespread availability of cost-effective technologies means that it can enhance competitiveness and provide net savings for households over the long term. Where these savings accrue to low-income people, it can take them out of fuel poverty and otherwise increase their living standards. These are great social, economic and environmental benefits. As discussed in Part 2, for a number of complex reasons realising them in practice is not easy. But where appropriate policies have been implemented, they have made a major contribution to sustainable development.

4.2 Renewables

The Government target for renewables is to have 10% of UK electricity supplied from renewable sources by 2010. Under the DTI Energy Paper 68 (DTI 2000b) medium economic growth scenario, total electricity generation by 2010 is projected to be 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 term significant contributions may also be expected from:

- Wave power;
- Tidal power (basin and flow);

- Solar (photovoltaics and thermal).

These are the technologies which will now be briefly evaluated from a sustainable development perspective.

Integrating the economic, social and environmental dimensions of quality of life

Renewables technologies are free of the large-scale, long-lasting pollution problems which make both fossil fuels and nuclear power environmentally problematic. However, they may nevertheless have visual or noise impacts or they may disrupt ecosystems. The impact is specific to the technology: tidal barriers disrupt wetland habitats, for example, and wind farms can disfigure valued landscapes. The latter can be important both for aesthetic reasons and for economic reasons, given the increasing economic contribution made by tourism to the rural economy. Impacts can be minimised through careful siting and appropriate technology choice. Ultimately, any residual, localised environmental impact has to be balanced against the environmental impacts avoided (which may be local, regional or global) by substituting renewables for other sources of energy supply.

Competitive economic activity and social well-being, even after demand-side measures, will continue to require a secure supply of electricity. The basic flow of renewable energy (wind, waves, solar energy) is both indigenous and, over time, can be predicted with relative assurance. However, many renewables only generate electricity intermittently, although some technologies (e.g. energy crops) generate less intermittently than others (e.g. wind power). The future security of supply from renewables, which is important to the social and economic dimensions of sustainable development, very much depends on what efforts are taken now to improve techniques for storing electrical energy and for balancing loads and supply across distributed networks. This is discussed further in Part 2.

Respecting biophysical limits

Renewables, by relying on the flows of energy that are already within the environment, operate intrinsically within biophysical limits. Energy-from-waste technologies, which are not accepted by everyone as renewables technologies, do not necessarily have this characteristic, because the production of the raw material for this technology – waste – may not respect biophysical limits, and the incineration of waste may give rise to pollution. However, even 'true' renewables can, as mentioned above, disrupt habitats and disfigure the countryside through inappropriate siting. Thus policies to promote renewables need to be careful over which technologies they support and where the technologies are situated. Biophysical limits might best be respected through policies that promote a portfolio of technologies that can be deployed sensitively. With respect to the biophysical limit with the greatest political salience at the moment – carbon emissions and their concentrations in the atmosphere – renewables technologies generally, having zero net carbon emissions in use, are not problematic at all.

Making the polluter pay

Not all renewables have negative environmental impacts locally, and in these cases application of the polluter pays principle would greatly favour them compared to other energy-supply technologies which have substantial local, regional and global environmental costs. As already noted, careful siting and choice of renewables technology can in many other cases reduce local environmental impacts to an extent that they are not widely experienced as costs. Generally it may be expected that if renewables are deployed sensitively, they will generate lower environmental costs than other sources of energy supply and would therefore be least affected by this criterion.

Protecting and enhancing UK competitiveness

The impact of renewables on UK competitiveness could be felt in two different ways. The first is through their impact on electricity prices and the knock-on effect on UK competitiveness. The second relates to the benefits to manufacturing from a thriving UK renewables industry able to compete in international markets. In both cases, there are both long and short term effects on competitiveness.

With regard to energy prices, it is how these compare with those of competitors now and into the future that is important. Here the impact will depend upon developments in renewable generating costs and in those of competing technologies. It will also depend upon international policies to control carbon emissions, and any rises in fossil-fuel prices due to falling or insecure output. At present some renewables technologies are close to being competitive with even the cheapest fossil fuels, and are likely to become so in the near future. Other technologies need further development and deployment to realise their potential cost reductions.

There is another cost consideration on which it is very difficult to obtain detailed information. As discussed in Part 2, the large-scale connection of intermittent, decentralised renewables to the grid has significant implications both for electricity distribution systems and for grid stability. Of benefit is the fact that the embedded nature of some renewables technologies (e.g. onshore turbines near communities or small-scale biomass power station) may reduce transmission and distribution losses. On the other hand, the need for stabilising measures for the grid, and the inherent unpredictability of some renewables, is likely to be a source of costs. It is currently far from clear what the scale of these benefits and costs are. This would seem to be a priority for further research.

Some indication of the impact of renewables on electricity prices can be obtained from the figures produced by ETSU for the UK Government (DTI, 1999). These suggest that a renewables programme that went some way beyond the Government's 2010 target would be unlikely to have a negative effect on the competitiveness of UK industry or the economy more widely. In any case, any effect from slightly higher prices for a period might be outweighed by the second competitiveness consideration, which is considered next.

Much energy supply capacity in industrial countries will be replaced, and much will be installed in developing countries, over the coming decades. If reducing carbon emissions intensifies as a global priority, then low-carbon energy technologies will be widely taken up. The companies and countries that develop expertise in these technologies can expect significant export opportunities, as, for example, Denmark is experiencing in relation to wind technology, in which it is a world leader. There would seem to be good prospects of foreign demand for a range of renewables technologies in the future, provided that their costs continue on their current downward trajectory, as is expected. It may be costly for the UK economy to have to import all the low-carbon energy supply (and efficiency) equipment which future restrictions on carbon emissions may require to be installed. Similarly, it is likely to be beneficial for the UK economy to develop the capacity to exploit its substantial renewable resources in such a way as to generate jobs and export revenues from the resulting industries.

Any consideration of the impacts on UK competitiveness from renewables must therefore take a dynamic, prospective, and global perspective. The short-term costs of renewables should be assessed alongside the longer-term export potential and the potential costs of import dependence if the UK is one of the last nations to venture down the low-carbon path.

Promoting social justice and inclusion

It is generally considered that the impacts of climate change will bear most heavily on poor people in poor countries, in this and future generations. Renewable energy technologies do not contribute to climate change, and in this sense they are socially just technologies.

The locally-based nature of many renewables technologies means that they give opportunities to move towards a more decentralised, community-based energy-supply system, in which people can participate in and have more influence over the decisions in this area that affect their lives, which is consistent with this sustainable development criterion. In addition, to the extent that renewables can be located in rural areas or on coastlines, where employment can be scarce, or contribute clean and competitive power based on indigenous resources to communities in poor countries, renewables may be said to promote social development and social inclusion.

Achieving energy security

Renewables are potentially the most secure energy source, with a very large indigenous, widely dispersed potential, which is not really subject at all to external disruption. Their technologies still need to be developed in order to deliver renewable energy in a competitive and socially and economically useful form, but these technologies have made great recent advances, and show much promise for the future. If a grid structure can be developed that allows the dispersed nature of renewables to be experienced as a benefit rather than a cost, and the sources can be developed in a complementary way to remove the disadvantages of the intermittency of some renewables, this set of energy sources offers excellent prospects for energy security.

Conclusion: renewables

In conclusion, renewables are often considered as the archetypal sustainable energy source, and certainly there is no question of depletion of wind, waves or solar power. Moreover, their exploitation leaves no lasting pollution problems for future generations. Providing their siting can be sensitive, so that they are integrated into landscapes rather than disfiguring them, they would seem to offer the best energy supply option for sustainable development as far as the environmental dimension is concerned. In strict financial terms, most renewables technologies are still some way from full competitiveness with fossil fuels, but the gap has narrowed significantly, especially for wind power, over the past decade, and more substantial cost reductions are in prospect. It seems likely that the large-scale deployment of renewables post-2010 will not have a significant negative economic impact, and could be the source of new industrial opportunity, jobs and exports, provided that in the interim judicious public support continues the process of market development and deployment. Socially, renewables offer a decentralised energy supply making use of local resources, which could re-connect communities with their use of energy and, in some places, offer new opportunities for employment and income. Renewables would seem, on this assessment, to perform very favourably against the sustainable development criteria.

4.3 Combining Policies for Energy Efficiency and Renewables

From the foregoing it is clear that both energy efficiency and renewables perform well in terms of sustainable development. However, there remains a question as to whether, on their own, they will sufficiently reduce energy demand or provide enough low-carbon energy to meet the UK's energy needs to 2050 in a way that also meets the RCEP's suggested target of a 60% reduction in carbon emissions by that date.

The Commission cannot take a definitive view on this question, consideration of which is a major task of the Energy Policy Review. However we would draw attention to a recent study which is so far the only one to have addressed this question comprehensively for the UK, and which did come to some conclusions on it.

The study consisted of a modelling exercise, using the MDM-E3 model managed by Cambridge Econometrics, which projected in a 'Total Programme' (TP) the economic and environmental implications of measures reflecting intensified policy support for renewables, CHP and household energy efficiency. The TP also included a doubling of the 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).

Three aspects of this modelling and its results are of interest in the context of this paper. First, the policy measures modelled include many of those which are discussed in Part 2 as likely to be necessary to secure deep cuts in carbon emissions. Second, the results of the modelling may be evaluated against the criteria of sustainable development which have already been extensively used in this paper. Third, the results may be compared with those in the CCP. Only the sustainable development assessment is included here. Consideration of the other issues is in Part 2.

The relevant Table in Part 2 summarises the results of the modelling. In brief, and as expected, the energy efficiency measures in the TP reduce energy demand in all sectors, and therefore carbon emissions. By increasing the energy efficiency of buildings, especially for low-income households, the TP also makes a contribution to reducing fuel poverty. The TP also greatly increases electricity generation from renewables, substituting for natural gas and coal and reducing both carbon and sulphur emissions. In total, carbon emissions in 2020 are 23% below their level in 1990, whereas in the Base Case they had returned to 1990 levels. Hence, in contrast to the Base Case, the TP may be considered to put the UK on a trajectory which is consistent with a 60% cut in CO_2 emissions by 2050. Economically, the TP results in small *increases* in GDP and employment by 2020.

A brief assessment of the TP against the sustainable development criteria used in previous sections leaves little doubt that such a scenario, were it to be achieved, would represent substantial progress towards sustainable development:

Integrating the economic, social and environmental dimensions of quality of life

The TP clearly addresses and integrates social, economic and environmental concerns. It results suggest positive achievements across all these dimensions.

Respecting biophysical limits

The TP reduces both carbon and sulphur emissions to levels closer to those which may be said to respect physical limits. This is especially the case for carbon emissions. The TP finally breaks the link between carbon emissions and economic growth.

Making the polluter pay

The TP increases the charge for pollution through the higher CCL and road fuel duties. In addition to encouraging energy efficiency, the CCL provides incentives for the development of renewables and the take up of CHP, both of which play a crucial role in reducing carbon emissions post-2010. Increases in road fuel duty encourage the purchase of smaller and more energy-efficient cars, as well as promoting the shift to alternative modes of transport.

Protecting and enhancing UK competitiveness

The TP makes a positive contribution to UK competitiveness, as shown by its higher GDP compared to the Base Case.

Promoting social justice and inclusion

The TP improves the housing stock, and therefore the living conditions, of low-income households. It also reduces unemployment, which is recognised as probably the single most important means of promoting social inclusion.

Achieving energy security

The TP reduces UK final energy demand by 8% by 2020, and increases the proportion of generation from indigenous renewables to 33%, of which no more than 20% is from intermittent sources, by the same date. This generation substitutes both for the nuclear plants which close before 2020, and, principally, for gas, leaving the UK much less dependent on foreign gas markets. The TP is clearly very beneficial for UK energy security.

Conclusion: combining policies

The modelling in the TP takes full account of the likely closure of nuclear capacity up to 2020. Its results, however, suggest that there is no need to replace old nuclear plant with new nuclear power stations to reduce CO_2 emissions beyond 2010. The issue of nuclear power has emerged as a major issue in the Energy Policy Review, and is considered in more detail, and in a sustainable development context, in the next section. However, these modelling results suggest that it will have to perform strongly across all the dimensions of sustainable development in order to justify public support in preference to the kind of policy package, promoting energy efficiency and renewables, which the modelling considered.

4.4 Nuclear Power

Unlike energy efficiency and renewables, nuclear power over the last fifty years received very substantial support from the public finances, the experience of which is briefly rehearsed in Part 2. In 1995, however, the Government concluded in its Nuclear Review (HMG 1995) that there was no continuing case for such support.

However, in respect of diversity, security of supply, and CO_2 emissions, the Government acknowledged that this conclusion was not necessarily final. At present nuclear power generates about 25% of the UK's electricity, but most nuclear power stations are scheduled for closure before 2020. 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. This is one of the central issues now being examined by the Energy Policy Review.

The issue before the UK Government at present is *whether* to give policy support to nuclear power, rather than *how* to do so. This is in contrast to energy efficiency and renewables, which are currently in receipt of substantial policy support. As a result, the Commission has not engaged in detailed policy analysis in respect of nuclear power. Instead, the relevant section in Part 2 simply reviews the issues related to nuclear power which are relevant to sustainable development. This allows a sustainable development assessment of nuclear power to be conducted, using the same criteria as before.

The issues related to nuclear power excite much controversy and disagreement. This is reflected, for example, in the very sub-title – Fuel of the Future or Relic of the Past? – of the booklet produced by the Royal Institute of International Affairs (Grimston & Beck, 2000) as an output of its ongoing enquiry into the future of nuclear power. It is not the intention of the Commission here to try to adjudicate between these opposing views. Rather the purpose of its sustainable development assessment is to see how well nuclear power performs against the criteria for the purpose of comparing this performance with that of energy efficiency and renewables.

Integrating the economic, social and environmental dimensions of quality of life

The possibility of a new nuclear programme in the UK is being considered because of the potential of this technology to contribute to the long-term security of UK energy supply and the long-term reduction of UK carbon emissions. These are important economic, social and environmental considerations. Modern economies require a secure supply of electricity, and nuclear power has shown that it can make a substantial contribution over a long period to electricity generation. Electricity is also a fundamental need for households in such societies as the UK. If there were no alternatives to nuclear power for electricity generation, it is likely that the UK public would accept it as essential for economic and social development, despite any environmental concerns.

Respecting biophysical limits

This criterion as used in this paper is based on the need "to ensure that the environment is protected and resources used in such a way that serious or irreversible environmental damage is avoided, potentially dangerous thresholds of environmental impact are not exceeded and important environmental functions are maintained for future generations to enjoy”. The nuclear radiation produced by nuclear power stations poses a substantial threat to human health and ecosystems, which persists over thousands of years. As a consequence, nuclear power has been subject to substantial opposition from environmental groups and their supporters. These groups have concerns over the risks from: accidents or deliberate attack; routine low-level radiation releases; the transport, storage, and disposal of low, medium and high-level nuclear waste; the decommissioning of nuclear power stations; and the proliferation of nuclear weapons. It is unlikely that these groups will agree that nuclear power satisfies this sustainable development criterion as phrased. As a result, they will continue to try to persuade policy makers and the public that nuclear power is incompatible with sustainable development on these grounds alone.

The advocates of nuclear power, in contrast, argue that nuclear power in OECD countries (with minimal exceptions) has in the past satisfied this criterion, and in the future it can be guaranteed that it will do so - i.e. the risks can be contained. Those who acknowledge some small residual risk consider that the benefits of the technology across the economic and social dimensions make this environmental risk (and therefore risk to human health) worth taking.

It is unlikely that these two viewpoints will converge sufficiently in the UK in the next few years for a new programme of nuclear power to be possible without large-scale opposition and political conflict.

Making the polluter pay

A major complaint from nuclear supporters is that the Government’s CCL is denominated in energy rather than carbon, and that nuclear energy is not exempt from it (like renewables), as it should be because it does not contribute to climate change. In terms of strict neo-classical economics, if the purpose of the CCL is to make energy prices reflect more nearly the costs of climate change, this complaint is justified.

However, if the purpose of the CCL is to reduce energy demand by encouraging energy efficiency, and to promote renewables, then the complaint can be dismissed, especially if it is also considered that nuclear power has uninternalised environmental costs of its own, which make it in its own way as problematic as fossil fuels. To make a sound decision against this criterion of sustainable development, it will be important to ensure that all the costs of nuclear power (as of other energy sources) are fully considered, especially those which, like insurance against accidents (some part of the liability for which for nuclear power is carried by the taxpayer), are often overlooked.

Protecting and enhancing UK competitiveness

It has already been noted that electricity is an essential input into the UK economy. It is sometimes said that ‘there is no electricity as expensive as no electricity’. However, as noted earlier, the UK currently has abundant electricity generating capacity, so that there is no comparison between the current UK situation and that, for example, in California. There is time to consider this issue in its full complexity in order to maximise the chances of getting it right.

The consequences for competitiveness of getting it wrong may be serious. One consideration is that a major programme of nuclear power (as for renewables) has the potential to kick-start a substantial UK export industry, but for that to happen there will need to be foreign demand for the technology. This emerged above as a significant prospect for renewables. But it is still highly uncertain whether nuclear power will achieve a world-wide revival and, if so, which of the several technologies being developed will be widely deployed, or whether the UK will have a competitive advantage in these technologies. The UK has got choices wrong in this area before (most notably with the AGR nuclear reactors) and should be especially wary of doing so again.

Another competitiveness consideration is cost. The UK needs a cost-competitive demand/supply mix. There are still considerable cost uncertainties with nuclear power, and a past history of cost underestimates, which should occasion special care to ensure that any new cost estimates are fully transparent and independently assessed, so that they may be judged to be soundly based.

Promoting social justice and inclusion

The implementation of the Fossil Fuel Levy in the early 1990s was not much noticed at the time. It added 10% to electricity bills, with the great majority of the revenues going to the nuclear industry, in principle to pay for eventual decommissioning of its power stations in more than 100 years time. With no compensating measures for those on low incomes, this was a very regressive way to achieve this objective. Furthermore, only a small portion of the Levy receipts were put into a fund for this purpose (MacKerron, 1995).

The energy sector will require large amounts of investment over the coming decades, whatever the energy demand/supply mix chosen. It will be important to ensure that, where the suppliers of this investment are not just private investors, the right balance is struck between resources from consumers and taxpayers, and that regressive effects of the kinds that have occurred in the past are avoided.

Finally there is an important issue of intergenerational justice to be considered with regard to nuclear power, comparable in some ways to the climate change issue. Nuclear power generates very long-lived toxic wastes, which will need to be safely managed or disposed of in such a way as to guarantee their isolation from the natural environment for many thousands of years. Over a shorter time frame, but still in a hundred years' time or more, very considerable resources will also need to be deployed to decommission nuclear power stations. In both cases the costs arising from nuclear power stations will long outlast the benefits of consuming the electricity produced by them.

It is theoretically possible to make provision now to meet these costs in the future (for example, NEA 2000, p.8, says "electricity consumers are paying for nuclear safety and insurance against nuclear accidents, decommissioning of nuclear facilities, and radioactive waste disposal", and the example of the Fossil Fuel Levy was noted above). But the resources being set aside today for these contingencies are very much lower than those that will be required to meet them, because of the assumption that they will grow along with the economy. However, to be adequate to the task they will need to grow over decades or centuries in line with the discount rate that has been applied. Over the occurrence of such growth, and therefore the availability of adequate resources, there is bound to be some uncertainty.

There is at least some possibility that future generations will find themselves with the liabilities of decommissioning and nuclear waste management, but not the resources to pay for them (see Thomas et al. 1994 for some discussion of this issue). Some would say that it was incompatible with the intergenerational equity aspect of social justice, and therefore with this sustainable development criterion, to saddle future generations with large and certain costs but uncertain means of meeting them.

Achieving energy security

Nuclear power in the UK depends on imported fuel (uranium). At present uranium supplies are plentiful, and they are located in a wide range of countries, which makes this energy source less problematic in terms of possible disruptions to supply than fossil fuels. However, if there were to be a major expansion of nuclear power worldwide, uranium supplies would become substantially depleted over fifty years so that the sourcing issue could start to give rise to security concerns (unless nuclear technologies depending on different fuels had been developed by then, but there is so much uncertainty over this possibility that it is not further considered here).

Nuclear power stations are currently built in large units, each of which provides a large tranche of base load power when it is operational, but which requires a similarly large back up source when it is out of action due to accidents or maintenance. Accidents at such plants can at least potentially be catastrophic, although some argue that the chances of such accidents are so low in well-managed plants as to be negligible. Nuclear plants also present potentially attractive targets for enemy or terrorist attack, both because of their large electricity supply capacity, and because of the damage which would be caused if their radiation were to be released.

New generations of nuclear power stations currently under development may be smaller and safer than those which have been built. It is, however, not possible to evaluate these against the sustainable development criteria used in this paper while they are still in the design stage and so much uncertainty as to their eventual nature and performance remains.

A final security consideration raised by a world wide expansion of nuclear power is the possibility of nuclear weapons proliferation. While it is certainly possible to seek to design international systems and institutions which limit this risk, the widespread use and availability of civil nuclear materials would certainly increase the probability of their diversion for military use, whatever security arrangements were in place to prevent this. This is a form of insecurity to which other energy sources do not give rise.

Conclusion: Nuclear power

This brief sustainable development assessment leads to the following general conclusions about the option of building new nuclear power stations in the UK.

If new nuclear build were the only way of addressing the security of supply issues identified for the Energy Policy Review, its potential contribution to energy security would be a very strong argument in its favour on both economic and social grounds. At a time when concern about climate change is also high on the political agenda, the fact that this energy source also emits no carbon would be a further powerful justification for maintaining or expanding the UK nuclear electricity capacity.

But, as has been seen in earlier sections, there are other ways of meeting the concerns about security of supply and climate change with which the Energy Policy Review is concerned, most notably the management of demand to reduce the required quantity of supply, and the deployment of renewable energy sources to meet the demand that is left. The question, therefore, is not whether nuclear power is consistent with sustainable development, but whether it is the *most* consistent of the energy demand/supply combinations that are available.

The combination of energy efficiency and new renewables was seen to perform strongly against all the sustainable development criteria. New nuclear build performs substantially less strongly against these criteria. In terms of sustainable development, therefore, it is not the first choice when it comes to meeting the energy demand and supply challenges of the future.

5. Conclusions and Recommendations

The Energy Policy Review must consider what decisions need to be taken now to meet the kind of energy challenges that seem likely in the first half of this century. The Commission has sought to contribute to this process by taking a rigorous view of the UK's energy options. In particular, it has sought to appraise current energy policy, and assess the main low-carbon options, on the basis of currently available technologies, for the future, against criteria which reflect its understanding of sustainable development. These options will need to be integrated in due course into a wider analysis which also considers the long-term role of fossil fuels, the possible development of carbon sequestration and such technological developments as fuel cells and wider possibilities for a 'hydrogen economy', which were outside the scope of this paper.

The essential question facing the Energy Policy Review is what will be the most economic mix in the medium to long term of demand-side measures, low-carbon energy sources, fossil fuels, carbon sequestration, and other technologies including nuclear fusion, fuel cells and the 'hydrogen economy' more generally, which will meet the challenges of ensuring diversity and security of supply and the mitigation of climate change. It will be apparent from the discussion above of just the immediately available low-carbon options that the answer to this question needs to take account of many complex issues for each of the different possible demand/supply combinations, assessing them for their economic, social and environmental impacts in a transparent, consistent and integrated way. As far as the Commission is aware, no such assessment has yet been made in any country. Our main conclusion is that the Energy Policy Review must at least show the way in this process for the UK.

Table 5.1 sets out a matrix for the assessment of energy technologies in respect of sustainable development. The matrix lists the major categories of demand and supply side technology options down the side, and across the top gives the sustainable development criteria, grouped under the three usual dimensions (economic, social, environmental) of sustainable development, with space left for other impacts not captured by the sustainable development criteria listed here.

Ideally a full sustainable development assessment of energy options would entail filling in the cells of the matrix with comparable, consistent, quantitative information expressed in money terms so that the optimal decision, taking account of all factors, could be made. However, it should be recognised that, however attractive this may be in principle, there is no way in which such a global cost-benefit analysis of the energy demand/supply options facing the UK, incorporating all the considerations discussed above, could be carried out such as to carry conviction across all those involved in this debate. The most that can, and should, be attempted is to lay out all the costs and benefits of the different options, quantified where possible but otherwise descriptively, in order that a well-informed public debate can take place and ultimately a political decision can be taken which represents the

Government's interpretation of what is in the UK's best interests. It is worth repeating that the most important required characteristics of this process are transparency, consistency in the comparisons and widespread participation in the debate.

On its own, much less detailed, sustainable development assessments, the Commission's conclusions may be briefly stated. Current Government policy is striking out on a relatively new course of encouragement of energy efficiency and stimulation of the take up of renewable energy sources. The analysis in this paper suggests that this is entirely in accordance with sustainable development criteria and that the technical and economic potential of this approach is very great. A modelling study reviewed above suggests that a programme of public support for renewables and energy efficiency could result in UK CO_2 emissions being 23% below their 1990 level by 2020, and lead to small economic benefits. Such results suggest that the next ten to fifteen years are critical. If renewables can be developed and energy efficiency measures implemented such that this kind of outcome is achieved over this time frame, then they will have evolved into substantial industries which should be able to move forwards on a commercial or near-commercial basis to make even deeper cuts in carbon emissions thereafter.

However, there are real concerns that the policies adopted will not succeed in achieving the targets for 2010 towards which they are directed, and will therefore also not succeed in putting the UK on an energy trajectory in the longer term which will meet the energy challenges identified in the Energy Policy Review. The danger is that the considerable technical and economic potential of energy efficiency and renewables will not be realised.

Part 2 of the paper has engaged in some detailed analysis as to why this may be the case, and has put forward some policy recommendations, the most important of which are summarised below. The Commission considers that it is extremely important that the necessary action is taken to ensure that the UK is able to reap the full benefits of energy efficiency and renewables technologies over the coming years. This combination is the first choice for sustainable development, and a failure to enable them to realise their full potential will amount to a considerable failure for sustainable development policy as a whole.

Nuclear power does not perform as well against the sustainable development criteria as energy efficiency and renewables. And on the basis of the above analysis, realisation of the full potential of energy efficiency and renewables would render the building of new nuclear capacity unnecessary. The duty of the Government to introduce policies to realise this potential cost-effectively is therefore clear. It is only if these policies fail to deliver this potential that the nuclear option will have to be seriously re-examined. For the moment, however, to revive serious consideration of the nuclear option would be to divert crucial political attention from the first choice for sustainable development – energy efficiency and renewables. The Commission does not believe that such a diversion is in the best interests of the UK or of sustainable development more generally. Rather it puts forward the following recommendations, summarised from those in Part 2

Table 5.1: A Matrix for the Assessment of Energy Technologies in Respect of Sustainable Development

ENERGY TECHNOLOGIES	SUSTAINABLE DEVELOPMENT CRITERIA										
			ECONOMIC			SOCIAL			ENVIRONMENTAL		
	Integration	Security	Competitiveness			Social exclusion			Respecting biophysical limits Making polluters pay		
			Financial costs (e.g. current costs, cost reductions)	Indus-trial oppor-tunity	Other impacts	Employment	Other impacts	Other impacts	Air emissions (e.g. CO_2, SO_2)	Other wastes (toxicity, length of life, risk of release)	Other impacts (e.g. visual, noise)
ENERGY EFFICIENCY											
CHP											
Households											
Industry											
Commerce, Public Sector											
Transport											
ENERGY SUPPLY											
Fossil fuels											
Renewables											
Nuclear power											
CARBON SEQUESTRATION											

of this paper, for consideration by the PIU Energy Policy Review in the belief that they represent the minimum policy interventions required for energy policy to move the UK adequately towards sustainable development.

RECOMMENDATIONS

5.1 Energy efficiency

Much more ambitious energy efficiency measures than those in the CCP 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.

5.1.1 Efficiency Potential and the Rationale for Intervention

- Energy efficiency scores highly against each of the sustainable development criteria and can simultaneously meet economic, environmental and social objectives. The Energy Policy Review should therefore give equal weight to issues of energy demand and energy supply. This will help redress the lack of attention to energy demand issues that has characterised energy policy to date.

- Evidence suggests that energy demand could be reduced by as much as a third through investments that are cost effective at current energy prices. However, 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. 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.

- Internalising the environmental costs of energy use in energy prices will increase the cost effective potential and stimulate technical innovation and will be essential for the achievement of a transition to a low carbon economy. 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.

5.1.2 Policies for Industry

- The CCL and negotiated agreements represent the most important developments in UK energy efficiency policy since the 1970s, but have led to an over-complex policy mix. This could be resolved by making it clear that the negotiated agreements are 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.

5.1.3 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.

5.1.4 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 in energy efficiency, and the poor quality of the UK housing stock contributes to widespread fuel poverty. The initiatives in the CCP do not address these problems to an adequate extent. 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.

5.1.5 Policies for the Transport Sector

- Transport provides the greatest challenge to the transition to a low carbon economy. 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.

- Long-term policy must simultaneously encourage alternative fuels, reduce energy intensity, promote modal shifts and reduce the need to travel, including through land use planning. Energy considerations need to be integrated into all aspects of transport decision-making.

5.2 Renewables

- 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.

- 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. However, 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.

- The Renewables Obligation (RO) 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.

5.3 Policy Impacts and Institutional Implications

- 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.

- Energy systems generally are now at a potential historical turning point, driven as much by technological changes as by environmental or other considerations, where they could either become consolidated in a centralised form following most of the experience of the last century, or begin a long-term process of decentralisation and dispersion in favour of more locally based forms of power generation, in particular. The UK is currently ill prepared for this latter possibility. The PIU Energy Policy Review should take the opportunity of showing how it could remedy this situation.

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,	% change per year		% change from 1990	
mtc	2000-10	2010-20	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:

- They could contract directly with local suppliers, thereby by-passing NETA arrangements and penalties.

- 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.

- 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									
Offshore wind		1.1	3.5	3.5	1.1	9.8	19.5	179	457
Energy crops		0.0	0.0	0.0	0.0	13.3	65.9	...	...
AFW		0.5	0.9	0.9	0.5	8.3	21.9	872	2448
		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: Due to rounding of underlying data, % change may not exactly reflect figures in the table

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.

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.

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