HOUSE OF LORDS

Science and Technology Committee

2nd Report of Session 2005-06

Energy Efficiency

Volume I: Report

Ordered to be printed 5 July and published 15 July 2005

Published by the Authority of the House of Lords

London: The Stationery Office Limited
£17.50

HL Paper 21-I

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(Q) refers to a question in the oral evidence

(p) refers to a page of written evidence

ABSTRACT

Energy efficiency is an essential plank of the Government's energy and climate change policies. The Government expect improvements in energy efficiency (that is to say, the more efficient use of delivered energy) not only to be translated into lower energy consumption, and thereby lower greenhouse gas emissions, but simultaneously to contribute to their other energy policy objectives—security of supply, greater competition in energy markets, and the reduction of fuel poverty.

This is a lot to ask, and in placing such weight on energy efficiency the Government appear to have no clear view on how to measure, and thereby manage it. We believe that reduction of the United Kingdom's absolute energy consumption, leading to reductions in emissions, should be the ultimate objective of energy efficiency. We propose a methodology to measure progress towards this objective.

At the same time, while the focus of policy shifts to the use of delivered energy the Government should not lose sight of the importance of enormous wastefulness of the electricity generating industry: in 2003 no less than 61.3 percent of the energy content of the fuel used in power stations was either dispersed into the atmosphere as waste heat or lost as a result of the inherent inefficiency of the generating process.

We recommend simplification of the plethora of departments, policy instruments and agencies involved in promoting energy efficiency. Government have a responsibility to provide clarity and leadership, something they are currently failing to do.

We have analysed in detail the wide range of "carrots and sticks"—regulatory instruments, fiscal incentives, and so on—that the Government are using to promote energy efficiency. Much is already being done, though we believe the Government could do more to develop markets for community heating, to raise product standards, and to sponsor energy research.

The Government should also be encouraging innovation in the construction industry, particularly given the scale of new housing development planned for the south-east. Progressive raising of the standards contained in Part L of Building Regulations (which still lag behind those in many other European countries), better enforcement of these standards, investment in training, skills, and applied construction research—the Government needs to do more in all these areas.

Changing behaviour will be crucial. Gains in energy efficiency are not necessarily translated into reductions in energy use—for instance better insulation may simply be used to provide higher internal temperatures. At the macroeconomic level, it has been argued that improvements in energy efficiency effectively reduce the price of energy, and as a result stimulate economic growth and increased energy consumption. The Government have yet to engage adequately with these behavioural issues.

Energy still figures low on most people's priorities, and consequently as a nation we are profligate in our waste of energy. Long-term reductions in energy use will only be possible if the millions of users—individuals, businesses, schools and other public-sector bodies—are educated, encouraged, and given access to real-time information on their use of energy and its costs, economic and environmental. People can only make good decisions if they have access to good information. We need to become a nation of mature, well-informed energy users.

Energy Efficiency

CHAPTER 1: INTRODUCTION

Scope

1.1. In July 2004 we appointed a Sub-Committee to explore the contribution that energy efficiency could make towards achieving the Government's objective, set out in the 2003 Energy White Paper[1], of reducing carbon dioxide emissions by 20 percent by 2010. We have examined in detail the practical measures designed to fulfil this objective which were outlined in the Energy Efficiency Action Plan[2], published in 2004.

1.2. The scope of our report is broadly similar to that of the chapter on energy efficiency in the White Paper. This means we have not addressed either low-carbon generation or transport. With regard to the former, we have already analysed the Government's policies to promote renewable electricity generation in our report *Renewable Energy: Practicalities*,[3] which our current Report is intended to complement. While we have included a chapter on encouraging markets for heat, in the process touching on renewable heat, particularly biomass-fuelled district heating and combined heat and power, we have not considered renewable energy in detail in this inquiry.

1.3. Nor have we considered transport. While acknowledging its critical importance to the Government's environmental objectives, we were aware that its inclusion would have hugely extended the scope of our inquiry. In addition, recent reports by House of Commons Select Committees on aviation, and on "cars of the future", have covered many of the issues that we might otherwise have addressed.[4]

1.4. This means that while we have addressed the two largest contributors to United Kingdom greenhouse gas[5] emissions—business and industry (representing almost a third of total emissions) and households (representing almost a quarter)—we have excluded a sector, transport, representing almost another quarter.[6] We note, moreover, that the projected expansion of air transport, and the continuing increases in road traffic, will mean that

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1 *Our Energy Future—creating a low carbon future*, February 2003 (Cm 5761)—hereafter referred to as the "White Paper".

2 *Energy Efficiency: The Government's Plan for Action*, April 2004 (Cm 6168)—hereafter referred to as the "Action Plan".

3 Science and Technology Committee, *Renewable Energy: Practicalities*, 4th Report, Session 2003-04 (HL Paper 126).

4 See Environmental Audit Committee, 9th Report of Session 2002-03, *Budget 2003 and Aviation* (HC 672), and follow-up reports; Transport Committee, 17th Report of Session 2003-04, *Cars of the Future* (HC 319-I).

5 The "basket" of major greenhouse gases as follows: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). As these gases vary widely in the extent of their impact upon the atmosphere, emissions are normally quantified in terms of carbon equivalence—most commonly, millions of tonnes of carbon equivalent (MtC). CO_2 is the least potent by weight, but by far the most significant in volume and overall impact, representing over 80 percent of United Kingdom emissions.

6 *Review of the UK Climate Change Programme: Consultation Paper*, December 2004, pp 20, 56.

transport emissions are projected to grow by some nine percent from 2000-2010, and that they are likely to continue to grow for the foreseeable future. At present the bulk of such emissions derive from road transport. However, as the House of Commons Environmental Audit Committee has repeatedly argued, the projected growth in air travel in coming decades means that emissions from this source, which as a result both of altitude and of the contribution of water vapour are 2.5-2.7 times more damaging than equivalent surface-based emissions, could "entirely negate" savings in other areas.[7] International action to address emissions from the transport sector will be essential if emissions are to be kept under control in the long term.

Acknowledgements

1.5. The membership of the Sub-Committee is set out in Appendix 1, and our Call for Evidence in Appendix 3. We received valuable written and oral evidence from the witnesses listed in Appendix 2. In October 2004 we held a seminar at the Institution of Electrical Engineers, to which a range of experts in the field contributed. In the course of our inquiry we also travelled to Germany and Sweden, while within the United Kingdom we visited the Building Research Establishment at Watford, Leicester, Durham University, and the Flagship Home in Knightsbridge. We wish to put on record our warm thanks to all those who have assisted us in our work.

1.6. Our Specialist Adviser for this inquiry was Professor Roland Clift, Director of the University of Surrey Centre for Environmental Strategy. We have been extremely fortunate to benefit from his expertise and enthusiasm, which have contributed enormously to our work.

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7 *Budget 2003 and Aviation*, p 9.

CHAPTER 2: DEFINITIONS AND MEASURES

Introduction

2.1. Energy efficiency is inherently a narrow term: technically, it refers to the proportion of energy within a fuel which is converted into a given output. However, when used as a policy term, as in the statement in the White Paper that it is "the cheapest and safest way of addressing all four [energy policy] objectives", it must have a broader meaning.[8] These objectives—the reduction of carbon emissions, the enhancement of the security of energy supplies, the improvement of the competitiveness of British businesses, and the reduction of fuel poverty—are diverse in nature. Can energy efficiency possibly deliver all these policy goals? Is too much weight being placed upon it, and is there a danger that policy-makers will lose sight of its essential meaning and limitations?

2.2. These questions in turn raise concerns over how energy efficiency is to be measured, and hence how targets can be set. In the course of our inquiry it has become increasingly clear that both energy efficiency itself, and the motivation behind the current emphasis upon energy efficiency, are poorly understood. Our aim therefore in this first chapter is to analyse what energy efficiency is, how it can be measured, and what it can be expected to achieve.

Background

2.3. The Government's appeal to "energy efficiency" as the means to achieve four distinct energy policy objectives is simply the latest proof that the term can mean different things at different times and in different places or circumstances. In the words of Professor Tadj Oreszczyn and Professor Robert Lowe, "The last 30 years of energy efficiency in buildings in the UK have seen a range of different policy instruments … motivated by a desire to improve security of supply, improve health and comfort, save money and energy and most recently, reduce carbon emissions." (p 70)

2.4. The Association for the Conservation of Energy (ACE) echoed this point, noting that in 1982-83 the House of Lords Select Committee on the European Communities (now the European Union Committee) justified what was then called the rational use of energy for "purely competitive, economic and strategic" reasons.[9] This report, prepared with the memory of the oil price shocks of the 1970s still fresh in people's minds, makes no mention of the environment. In marked contrast, by the early 1990s the same Committee had concluded that "there is now an environmental imperative to save energy".[10] (p 57)

2.5. In the last decade more evidence has emerged on the rate of climate change,[11] which has become, in the words of the Prime Minister in

8 The words quoted are from paragraph 1.19.

9 House of Lords Select Committee on the European Communities, *The Rational Use of Energy in Industry*, 8th Report, Session 1982-83 (HL Paper 83), pp viii-ix.

10 House of Lords Select Committee on the European Communities, *Energy and the Environment*, 13th Report, Session 1990-91 (HL Paper 62-I), p 23.

11 This evidence is drawn together in the Third Assessment Report by the Intergovernmental Panel on Climate Change, published in 2001 (http://www.ipcc.ch). For the Prime Minister's speech see http://www.number10.gov.uk/output/page6333.asp.

September 2004, "the world's greatest environmental challenge", a phenomenon "so far-reaching in its impact and irreversible in its destructive power, that it alters radically human existence". However, despite this reinforcement of the environmental rationale for energy efficiency, the Government continue to insist that energy efficiency must be made to serve all four energy policy objectives without giving explicit primacy to any one of them.

2.6. Just as the four objectives of Government energy policy differ in nature, so the way in which the contribution of energy efficiency to their achievement is measured necessarily differs in each case. As a general rule, what cannot be measured cannot be managed, so if something is measured in several different ways management becomes, to say the least, problematic. There is no doubt that energy efficiency potentially impacts on a wide range of policy objectives. However, the Government's approach, presenting energy efficiency as all things to all men, risks creating confusion. The written evidence presented by the Government was opaque and unstructured, with a series of numbered annexes (some previously published); in oral evidence we found it equally difficult to get at a clear sense of the fundamental policy, while our discussions with other witnesses have revealed a multiplicity of incentives, instruments and agencies active in the field—in short, muddle.

2.7. **Energy efficiency has been drafted into the service of a wide range of policy objectives since the 1970s, but the way it has been understood and measured has been elusive and variable. We have been dismayed in the course of our inquiry by the inconsistency and muddle of much current thinking about energy efficiency.**

2.8. **This muddle is not the sole responsibility of Government, but only Government can resolve it. However, the current attempt to present energy efficiency as "the most cost-effective way to meet all [four] energy policy goals" only adds to the confusion. At the very least, careful oversight will be needed to ensure that the targets set for energy efficiency are defined, that conflict between them is avoided, and that progress is measured. We urge the Government to bring greater clarity and intellectual rigour to its presentation of energy efficiency.**

Measuring energy efficiency

2.9. As we have already noted, energy efficiency is strictly speaking a narrow technical term. For this reason various proxy measurements are used in assessing its contribution to energy policy. Broadly such measures fall into three categories:

- The amount of energy consumed in relation to particular outputs or quantities: for instance, terms such as energy intensity and energy ratio are used, though not always consistently, to describe total energy consumption per unit of GDP, or energy consumption per head of population, or per household.
- Impact on absolute energy demand, measured either in terms of delivered energy (the energy provided to end-users) or primary energy (the energy resources feeding into the economy and converted into convenient forms such as electricity).

- Impact upon carbon equivalent emissions, often used as a proxy for changes in energy efficiency. This impact may be measured either in absolute terms, or in terms of carbon intensity—that is, carbon equivalent emissions per unit of GDP.

2.10. None of these measures is ideal, since each incorporates a number of variables which obscure the impact of energy efficiency *per se*. Energy intensity, for instance, which, as the Government note, is "traditionally … used as a proxy for energy efficiency" (p 4), may be affected by wider structural changes—in the case of the United Kingdom in recent decades, the decline of carbon-intensive industries such as steel and coal, and the move towards a service economy. On the other hand, although energy efficiency is conventionally regarded as the rate at which delivered energy is converted into useful outputs, concentration on delivered energy alone would risk overlooking the effects of economic or demographic changes, not to mention the impact of fuel switching (e.g. from coal to gas in electricity generation), which has a profound impact upon primary energy demand and greenhouse gas emissions. In the words of the Royal Academy of Engineering, "of all energy measures, [delivered energy] is the most misleading" (p 2).

2.11. So what is the Government's preferred measure? We have already noted that the Government see energy efficiency as a means of delivering all four White Paper objectives—unfortunately the inconsistencies between these objectives mean that the Government seem unable to agree upon a single measure. The Executive Summary to the Action Plan, for example, notes that "energy efficiency has been improving steadily over recent years". It then asserts that "across the economy as a whole … we could reduce energy use by around 30 percent". The next sentence continues, "The White Paper identified potential savings of around 10 million tonnes of carbon by 2010, and a similar quantity by 2020". Efficiency, energy demand, carbon—the relationships between them are wholly unclear.

2.12. In contrast, Ofgem brought a welcome note of clarity to the issue of measurement with regard to specific policy objectives: "It is … important for the programmes to be measured in the units of their objective: that is if the programme is being designed to reduce carbon emissions the activity being promoted should be measured in units of carbon abated and similarly if the programme is intended to reduce the numbers of those in fuel poverty then the success of the programme should be measured by the numbers taken out of fuel poverty. Neither the Warm Front programme or the EEC[12] are measured in such a way". We agree. (p 307)

2.13. The evidence presented by the Government to this inquiry did not get us much further in identifying a preferred measure of energy efficiency, though it did establish the Government's wish to bring out what Mr Jeremy Eppel, of Defra, called "the totality of systemic energy policy". Within this totality, he told us, the Government's new emphasis on energy efficiency marked a new focus on "final energy use more than primary energy use". (QQ 3-4)

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12 The Warm Front programme is dedicated to improving housing standards and reducing fuel poverty; the Energy Efficiency Commitment (EEC) is a commitment taken on by energy suppliers to install energy efficiency measures in domestic properties with a view to reducing carbon emissions.

2.14. It may be helpful therefore to break down the "totality of systemic energy policy" into stages. This reveals inefficiencies at every stage of the process of converting primary fuel sources into useful outputs:

- Acquisition of fuel: the extraction, refining and transportation of bulky fuels, such as fossil fuels and biomass, itself consumes a substantial amount of energy.
- Generating inefficiency: there are limits on the levels of efficiency that can be achieved in converting primary fuels into delivered energy—these are particularly marked in the case of electricity generation. The most efficient devices for generating electrical energy from fossil fuel, Combined Cycle Gas Turbines, currently operate at efficiencies of 45-50 percent; over 50 percent is possible, but that takes one close to the thermodynamic limit, which represents an absolute constraint. Efficiencies in exploiting heat, on the other hand, are not subject to the same thermodynamic limit, and are therefore much higher, reaching 90 percent or more. By using some of the low-grade heat rejected from electricity generation combined heat and power (CHP) plants can achieve 80 percent or more total conversion efficiency.
- Distribution: all transmission and distribution systems lose energy. Within the United Kingdom it is estimated that 1.5 percent of electricity is lost via the transmission network, and a further 6 percent between grid supply points and customers' meters—a total of 7.5 percent, or some 30 TWh/year.
- Technical inefficiency: this covers all sorts of technical energy loss, from inefficiency in buildings (such as poor insulation), through boiler inefficiency or the overpowering of motors in domestic and commercial appliances such as refrigerators, to efficiency of industrial processes.
- Behavioural inefficiency: even with efficient appliances or buildings, consumers still use them inefficiently. They may waste energy by leaving lights on, electrical appliances in standby mode, or doors or windows open. They may also find new and extravagant ways to use energy, such as patio heaters, in order to enhance their quality of life.

The first three bullet points are concerned with the delivery of energy (in either its primary form, such as gas, or converted into electricity) to end users. "Energy efficiency" is conventionally regarded as being concerned with the last two, and these will be the focus of this report.

2.15. However, as Tom Delay, Chief Executive of the Carbon Trust, told us, greenhouse gas emissions link all the stages—carbon, he argued, was the "only common currency" allowing one to assess the totality of energy policy, and the role of energy efficiency within it (QQ 71-72). Energy efficiency is a means to an end, and any measure must therefore be composite—that is to say, it must focus on the potential for a reduction in demand for delivered energy, which will in turn be related to the achievement of a specific policy goal. Of all the Government's long-term goals for energy policy, tackling climate change has been identified as the "greatest challenge"; given that carbon is also the only common currency linking all stages of energy production and use, we believe that carbon should be the ultimate measure of energy efficiency.

2.16. This is the approach we have adopted in this Report. To avoid confusion between "energy supply" and "energy efficiency", we have focused on delivered energy, and have not assumed a major shift in energy supply towards low-carbon sources such as renewables or nuclear power. However, we have considered possible changes from one form of delivered energy to another. As background, we have also investigated how the carbon intensity of delivered electrical energy has changed since 1990 (see below, paragraphs 2.41 ff).

2.17. **In September 2004 the Prime Minister identified climate change as "the world's greatest environmental challenge". We agree, and believe that the fundamental objective of policies in favour of energy efficiency at the present time must be the absolute reduction of carbon emissions. This objective must be reflected in the setting of targets for and the measurement of energy efficiency. While the targets in the White Paper have been expressed in terms of reductions in carbon equivalent emissions, the confusion of measures that is found elsewhere in Government policy statements undermines their credibility. We recommend that the Government henceforth adopt a more rigorous approach to the measurement of energy efficiency in terms of carbon.**

Establishing a baseline

2.18. Measuring energy efficiency in terms of carbon will only make sense if there is a clear methodology for assessing the carbon impacts of changes in energy demand, and if the baseline for assessing carbon emissions is transparent and consistent. Unfortunately, the presentation of the Government's targets for reducing carbon emissions is profoundly confusing.

2.19. In outline, the Kyoto Protocol, which came into force in February 2005, commits the United Kingdom to reducing greenhouse gas emissions by 12.5 percent below 1990 levels by 2008-12.[13] This reduction had already been achieved by the turn of the century, and although emissions of carbon dioxide have since crept back up the United Kingdom remains on target to meet its Kyoto obligations through reductions in emissions of other greenhouse gases. In addition, the Government have adopted a national target to cut carbon dioxide emissions by 20 percent below 1990 levels by 2010 (that is, from 165.1 MtC to 132.1 MtC). They have also accepted the recommendation of the Royal Commission on Environmental Pollution (RCEP) that the United Kingdom seek to cut carbon dioxide emissions by 60 percent by 2050.[14] These various figures and targets are summarised in Table 1.

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13 The base year figure (which in fact incorporates 1990 emissions of CO_2, CH_4 and N_2O, and 1995 emissions of HFCs, PFCs and SF_6) is currently calculated to be 209.7 MtC. The United Kingdom is obliged to cut this to 183.5 MtC, averaged over the five years of the commitment period.

14 A cut of 60 percent, if replicated by other developed countries, would allow stabilisation of carbon dioxide concentrations in the atmosphere at no more than 550 parts per million, the target adopted by the RCEP.

TABLE 1

United Kingdom greenhouse gas and carbon dioxide emissions and targets

	Total GHG emissions	*CO_2 emissions*
UK Kyoto baseline	209.7 MtC	165.1 MtC
UK 2003 emissions	181.7 MtC	156.1 MtC
Kyoto target (average for 2008-2012)	183.5 MtC	-
Domestic target for 2010	-	132.1 MtC
RCEP target for 2050	-	66.0 MtC

2.20. However, when it comes to monitoring these commitments and setting specific interim targets confusion begins to set in. The cuts in emissions described in the White Paper and the Action Plan, for example, are set not against actual 1990 levels, or even the composite Kyoto baseline, but against "baseline projections" for carbon emissions which in turn derive from the 2000 Climate Change Programme. These baseline projections, which took into account the effect of structural changes in the 1990s, as well as policies that had been introduced since Kyoto, were for CO_2 emissions of 153.8 MtC by 2010, and total greenhouse gas emissions of 180.2 MtC.[15]

2.21. The 2000 Climate Change Programme also proposed a range of new measures, which have been implemented over the past five years. It stated that these new measures would deliver, compared to the baseline projections, an additional 17.75 MtC reduction in emissions by 2010, of which 10 MtC were ascribed to energy efficiency.[16] Such reductions were to deliver, compared with 1990, a 19 percent reduction in carbon dioxide emissions (to 136 MtC), and a 23 percent overall reduction in greenhouse gas emissions (to 163 MtC).

2.22. Adding to the confusion, whereas the Climate Change Programme, under the heading "Bringing it all together", gives projections for 2010, the White Paper, published three years later, sets its own vaguer but more ambitious goals for 2020. It asserts that with the measures in the Climate Change Programme the United Kingdom's CO_2 emissions might amount to 135 MtC in 2020, and then sets out the aim of reducing emissions by a further 15-25 MtC below that level (in other words, to 110-120 MtC). Of these further reductions, some 10 MtC are projected to be from energy efficiency (and are thus in addition to the 10 MtC savings from energy efficiency already expected to emerge from the Climate Change Programme by 2010).[17]

2.23. However, in the Action Plan, published a year later, the focus returns to 2010. The projections change yet again—rather than the 10 MtC set out in the Climate Change Programme, the Action Plan projects savings from energy efficiency of 12.1 MtC by 2010. However, the Action Plan makes no projections for 2020. The divergence from the White Paper is explained by

15 *Climate Change: The UK Programme*, November 2000 (Cm 4913), p 53.

16 Ibid., p 125.

17 See White Paper, pp 26, 32-33.

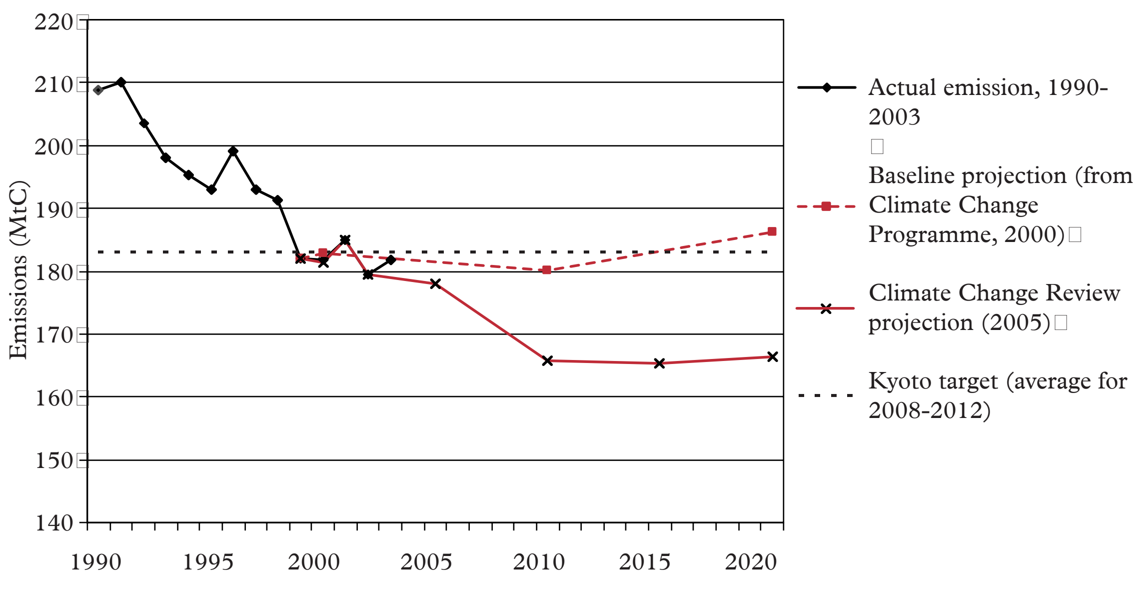
the fact that its projections "were not intended to be rigid targets but illustrated the scale of carbon savings which could be achieved".[18]

2.24. The White Paper and the Action Plan do not seek to update the 2000 Climate Change Programme projections across the board. However, in December 2004 the Government published its *Review of the UK Climate Change Programme* consultation paper. This reveals that whereas the 23 percent cut in greenhouse gas emissions by 2010 described in the original Climate Change Programme would have meant total emissions of around 163 MtC, the latest projection is that they will stand at 165.4 MtC. Instead of the projected 19 percent cut in CO_2 emissions by 2010, to 136 MtC, the latest projection is that they will stand at 142 MtC, a drop of just 13.8 percent from 1990 levels.[19] It is notable that the Review also suggests that by 2020 CO_2 emissions are likely to stand at just under 144 MtC, compared with the 110-120 MtC described in the White Paper.

2.25. The picture is thus extremely muddled. Figures 1 and 2 give actual data from 1990-2003 for greenhouse gas and CO_2 emissions respectively, combined with the projections for 2000-2020 given in the Climate Change Programme and the 2004 Review. They also illustrate how these projections compare with the United Kingdom's Kyoto obligation to reduce greenhouse gas emissions, and the two domestic CO_2 targets—the Government's national target for 2010, and the more speculative goal for 2020 contained in the White Paper.

FIGURE 1

Greenhouse gas emissions since 1990, projected to 2020

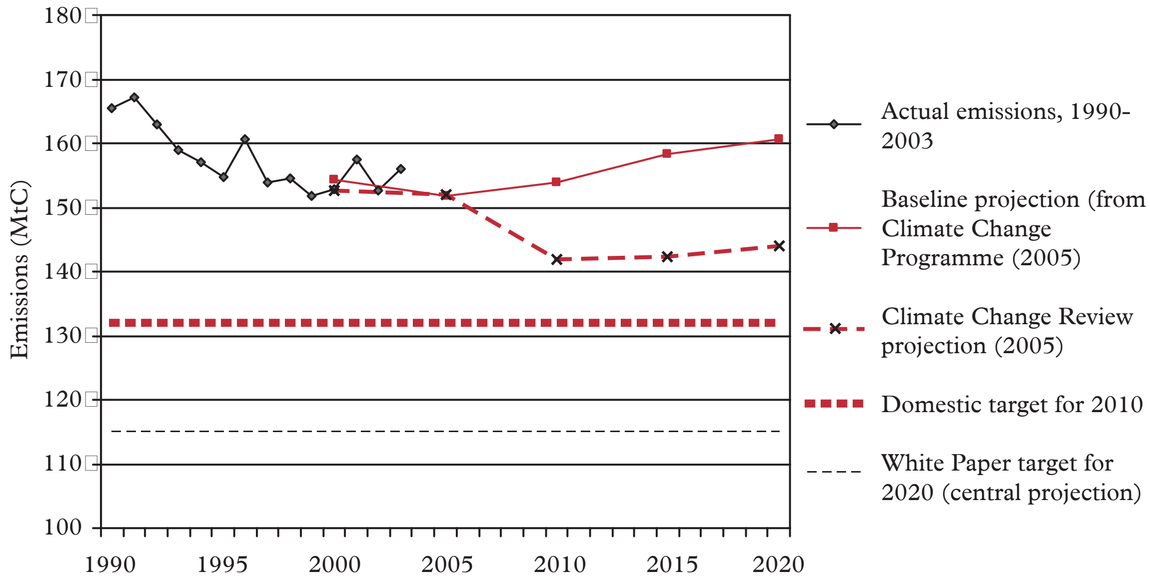


18 Action Plan, p 10.

19 Review of the UK Climate Change Programme, p 23. Another layer of confusion is added by the fact that the "baseline" figure for 1990, which in 2000 was set at 211.7 MtC, is now set at 209.7 MtC.

FIGURE 2

Carbon dioxide emissions since 1990, projected to 2020



2.26. The graphs demonstrate the difficulty in knowing what credence to give to the targets described in the White Paper and the Action Plan, given that they are not savings against a real baseline, but against changing projections, which are in turn based in turn on a variety of assumptions regarding economic growth, energy prices, the impacts of policies, and so on. This may appear to be an academic issue. However, two examples will suffice to show that changes in baseline projections can have a serious impact on present policies. The first example is the change in the target for energy efficiency announced in the Action Plan, which, while increasing the 2010 energy efficiency target from the 10 MtC described in the White Paper to 12.1 MtC, announced a reduction in the share of this total ascribed to domestic energy use from 5 to 4.2 MtC. This was described by the Association for the Conservation of Energy as "an extraordinary reversal of Government policy", which had caused a "crisis of confidence" (p 56). Mr Nick Eyre, of the Energy Saving Trust, which is sponsored by Defra, admitted that "we were never quite clear" why the target had been changed—but he thought it might be the result of "technical issues around what the base line is" (Q 287).

2.27. Another potentially more serious example concerns the National Allocation Plan (NAP) for the EU Emissions Trading Scheme. We discuss this in more detail in Chapter 10. At this point we note only that the United Kingdom last year sought an increase in the level of emissions allowed for British businesses under the Scheme, on the basis that the revised projections for "business as usual" emissions indicated that the baseline would in fact be higher than expected. The Commission has refused to allow the increase, and as a result, while the Government have agreed to make allocations to individual sectors according to the original NAP, they are apparently considering legal proceedings against the Commission.

2.28. Against this background, it is not surprising that our witnesses from Defra, pressed on the nature of the proposed energy efficiency savings, quickly found themselves in difficulty:

"They are real relative savings. They are measured against the baseline that was projected … in the … Climate Change Programme for 2010, so relative to that baseline, which is the standard baseline that we use for various policies related to carbon emissions, they are genuine reductions on what would otherwise have happened had these policies not been put in place." (Q 18)

2.29. We cannot follow this argument. If savings are real, they cannot be relative—it is meaningless to talk of savings against what might have happened had certain policies not been in place. For example, the Government have now conceded that their Climate Change Programme targets for 2010 are unlikely in fact to be met. Against this background, what is now the status of the 10 (or 12.1) MtC savings assigned to energy efficiency? Admittedly the calculation of greenhouse gas emissions, and the attempt to quantify savings, in light of variables such as rates of economic or population growth, structural change, and so on, is far from straightforward. Nevertheless, the Government's approach, with its proliferation of projections and targets, has created confusion and uncertainty, which risks compromising the practical delivery of carbon savings.

2.30. **Levels of carbon emissions should be grounded in clear historical data, not hypothetical projections. Insofar as projections are necessary, the methodology on which they are based should be explicit, transparent and consistent. None of these requirements is being met at present. The "baseline" for the White Paper targets, which is derived from the projections contained in the 2001 Climate Change Programme (which itself took into account the impact of policies introduced by the Government after the signing of the Kyoto Protocol in 1990) is obscure. We recommend that the Government ground its targets more firmly in reality, making it clear how they are derived and expressing them in absolute year-on-year carbon equivalent emissions.**

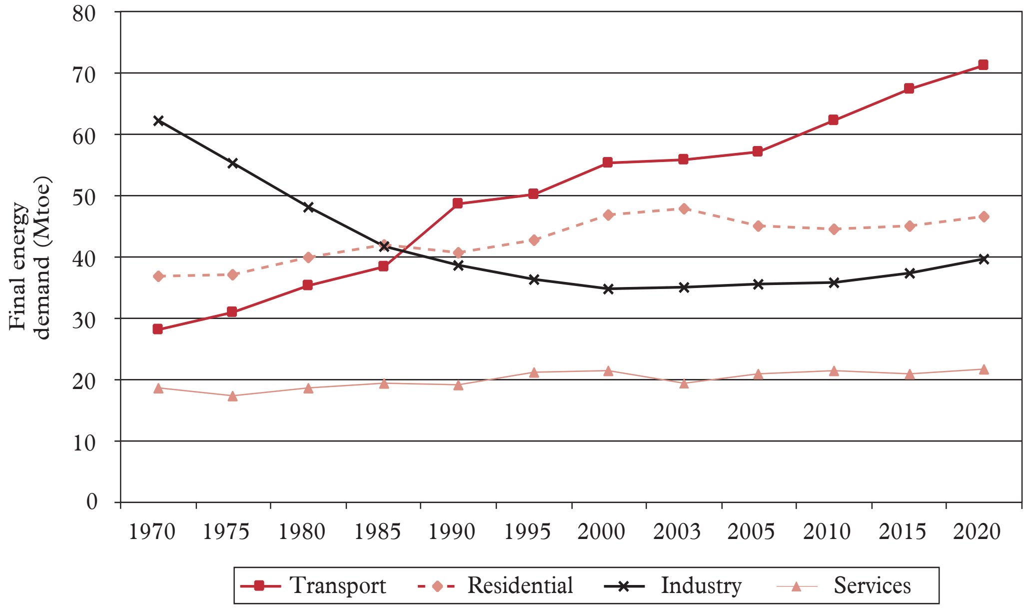
Energy efficiency and carbon: the scope for savings

2.31. Figure 3 shows changes in United Kingdom energy demand by sector from 1970-2003 (included in the graph as the last year for which final data are available), derived from the Digest of UK Energy Statistics (DUKES), and combines these figures with the DTI's projections for future energy demand. These projections take account of policy measures already in place, including, for instance, EU Emissions Trading. However, they become, as the DTI acknowledge, increasingly uncertain as one moves towards 2020.

2.32. The historical data illustrate the fundamental change of the last 35 years: a huge decline in industrial energy use (from 62.3 Mtoe in 1970 to 35.1 Mtoe in 2003), counterbalanced by an equally dramatic rise in the use of energy for transport (from 28.2 Mtoe in 1970 to 56 Mtoe in 2003). In contrast, energy consumed in services (a catch-all, including commercial and public sectors and agriculture) has remained flat, while energy consumed in the residential sector has crept slowly, but consistently upwards (from 36.9 Mtoe in 1970 to 47.9 Mtoe in 2003).

FIGURE 3

UK energy demand by sector, 1970 -2020



Source: Energy Sector Indicators (1970-2003), DTI Emissions Projection (2005-2020). An estimate of net energy consumption by the iron and steel industries has been added to the DTI's projections.

2.33. The projections reveal not only where the Government see scope for future savings by means of energy efficiency, but the extent to which such expectations mark a departure from or a continuation of existing trends. They show, for instance, that while domestic energy consumption has, allowing for variations in individual years, shown a consistent upward trend for 35 years, the Government, despite their major programme of house-building, which is expected to result in almost two million new houses being built by 2015, expect the trend to be partially reversed before energy consumption stabilises at a slightly lower level than in 2003.

2.34. On the other hand, industrial energy consumption experienced a long decline, before levelling off in the late 1990s. The Government now expect it to remain at a similar level before increasing somewhat after 2010—again reversing a 35-year trend. Yet the Action Plan envisages that a further 3.8 MtC "saving" can be delivered by energy intensive industries by 2010—illustrating just how hypothetical many of the projected "savings" in fact are.

2.35. Finally, the graph shows that consumption of energy for transport—which, as we have already noted, falls outside the scope of this report—is expected to carry on rising inexorably, to such an extent that total energy consumption in 2020 is projected to be around 13 percent above 2003 levels. In the absence of serious action to tackle the growth in both road and air travel, there must be a risk that energy efficiency gains in other sectors will be wasted.

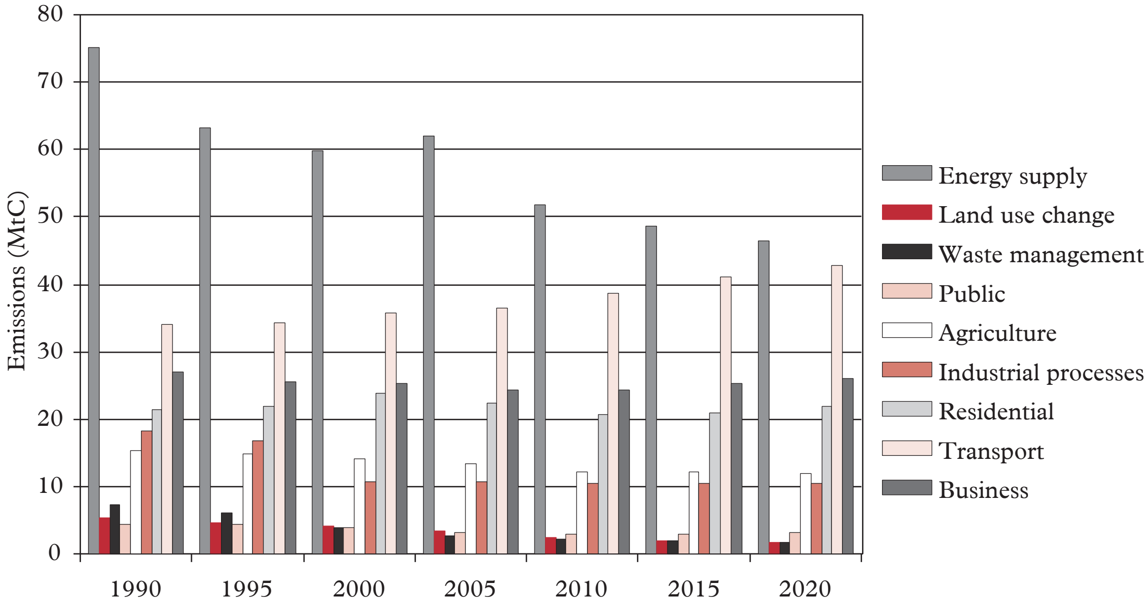
2.36. The graph thus provides a snapshot of the scale of the challenge—more detail on the targets and policies affecting particular sectors is given in the relevant chapters below. However, it is when one tries to translate the data on energy use into carbon, which we have already proposed as the principal objective for energy efficiency, that the problems really start.

2.37. The fundamental difficulty is that while changes in energy efficiency affect the consumption of delivered energy, Government data on greenhouse gas emissions are derived from the *UK Greenhouse Gas Inventory*, the annual report prepared under the United Nations Framework Convention on Climate Change. Within the inventory, which follows IPCC guidelines, emissions are assigned to designated source categories, with the result that some 85 percent of emissions (including, for example, those derived from the combustion of fuel for transport, or domestic heating, as well as those from electricity generation) are lumped together under the general heading of "energy". Other sources of emissions, such as those from landfill sites, are unrelated to energy consumption at all. As a result there is no direct read-across from the data on greenhouse gas emissions to energy efficiency and end use.

2.38. Figure 4, which presents in bar chart form the data contained in Table 3 of the Climate Change Programme Review, illustrates the problem. In an attempt to show the sources of emissions more usefully than in the Inventory, the Government have broken "energy" down into smaller categories, for instance treating combustion of fuel (petrol, natural gas, and so on) for transport or residential uses as distinct "sources" of greenhouse gas emissions, and creating a new category of "energy supply", which is presumably largely made up of electricity generation. However, the methodology underlying the Government's approach is frustratingly obscure, and leads to serious anomalies. For instance, while the combustion of gas for domestic central heating is treated as a distinct "source" of greenhouse gas emissions, domestic electrical heating appears to fall under the heading "energy supply". As a result of these anomalies, Figure 4 has limited value for our present purposes.

FIGURE 4

Greenhouse gas emissions by source, 1990 - 2020

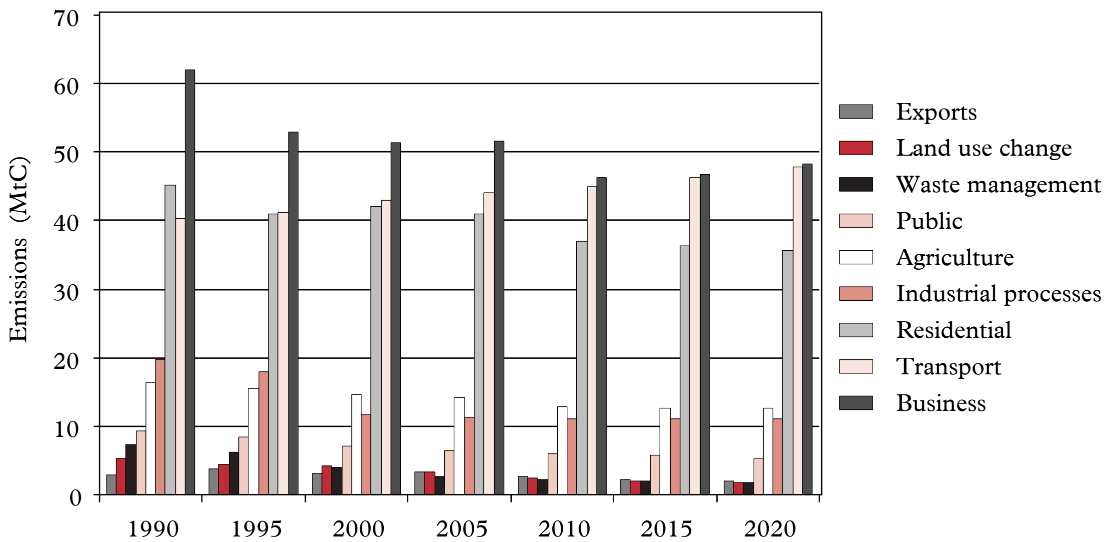


Source: Climate Change Programme Review.

2.39. Figure 5 illustrates in similar form the data contained in Table 4 of the Climate Change Programme Review. In this the Government have assigned emissions, including those deriving from energy supply, to end users, and the result should therefore in principle be more informative. Unfortunately, it is impossible to read across from these data to the raw figures contained in DUKES. The categories overlap in ways that are not explained—for instance, whereas DUKES draws together industrial energy use under a single heading, in Figure 5 industrial emissions appear to be split up, in ways that are not explained, between "business", "industrial processes", and possibly other categories. Furthermore, the presentation of non-energy related sources of emissions, such as landfill sites or particular processes such as the de-carbonation of limestone in cement manufacture, as "end users", is intrinsically artificial and confusing. Thus Figure 5 too is of limited value in assessing the impact of changes in consumption of delivered energy upon carbon emissions.

FIGURE 5

Greenhouse gas emissions by end-user, 1990 – 2020



Source: Climate Change Programme Review.

2.40. In an attempt to pin down the relationship between energy efficiency and carbon rather more closely, we have commissioned research from Dr Phil Sinclair, of the University of Surrey, into household energy consumption and related carbon emissions.[20] Dr Sinclair's methodology is summarised in Box 1. He has used figures for energy consumption that are publicly available in DUKES, and has converted them from thousand tonnes of oil equivalent (ktoe) into a simple measure of gross energy, expressed in primary energy unit of joules.[21] His analysis shows that from 1990 to 2002 total United Kingdom household consumption of delivered energy rose by some 17 percent. This total includes fuels used for heating as well as electricity.

2.41. The second part of Dr Sinclair's work is an analysis of the carbon intensity of the fuel mix, taking a "life cycle" approach—in other words, including such

20 Dr Sinclair's paper is printed in Appendix 4.

21 1 kWh = 3,600,000 joules, or 3.6 MJ.

factors as system losses, losses in fuel extraction, conversion efficiencies, and so on. Multiplied by the figure for total energy consumption, this produces an overall figure for carbon emissions resulting from household energy use, which, by Dr Sinclair's calculation, have fallen over the same period by just over half of one percent.[22] Significantly, while the results of Dr Sinclair's analysis correspond to within a few percentage points with the Government figures, so as to indicate broad consistency between the two independent calculations, there are enough differences to demonstrate the difficulty of establishing a clear link between the Government's existing data on emissions and those on delivered energy consumption.

BOX 1

Calculating the effect of energy use upon emissions

- Energy efficiency primarily affects the consumption of delivered energy, for which annual data are found in the Digest of United Kingdom Energy Statistics (DUKES).
- Data from DUKES for total energy consumption in a given year are converted into a neutral measure of gross energy (joules).
- DUKES also provides data on the contribution of different primary fuels (such as coal, gas or oil) and of electricity to the total.
- The carbon intensity of the total fuel mix in that year is then calculated, on the basis of a "life cycle" approach—taking into account fuel extraction, conversion efficiencies of electricity generators, and so on.
- Consumption of delivered energy is multiplied by the figure for carbon intensity to produce a figure for the greenhouse gas emissions deriving from the consumption of delivered energy in that year.
- Greenhouse gas emissions as a result of non-energy based activities (e.g. certain industrial process, the decay of waste in landfill sites, or changes in land use) are excluded. As a result this methodology provides an accurate picture of the impact of changes in consumption of delivered energy upon emissions.

2.42. Dr Sinclair's calculations cover only the domestic sector, and may require refinement. However, as an attempt to establish a methodology for converting energy use into the common currency of carbon, we believe that it introduces greater clarity into the discussion of energy efficiency, by setting out an explicit methodology for translating data on energy consumption into carbon emissions. Only if the Government adopt a similar methodology will it be possible to demonstrate that their policies on energy efficiency are grounded in reality and are delivering tangible results. We believe this to be an essential pre-requisite for public information programmes to promote energy efficiency.

2.43. **In order to be able to measure the contribution of energy efficiency to emissions targets, the Government should develop and publicise an explicit and transparent methodology for calculating the relationship between use of delivered energy and greenhouse gas emissions. We have commissioned research which provides one such methodology, which we believe provides the basis for developing a reliable tool for**

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22 The Government state on p 63 of the *Review of the UK Climate Change Programme* that household CO_2 emissions have fallen by around 3 percent since 1990; see also the graphs and tables of CO_2 and greenhouse gas emissions (pp 21-27).

measuring the contribution of energy efficiency to reductions in greenhouse gas emissions. We draw it to the attention of Government.

The fuel mix

2.44. We have already noted that energy efficiency is just part of the story so far as overall energy use and its carbon impacts are concerned. Our approach to measurement embraces two components: a figure for the gross amount of energy actually used by consumers, and a "multiplier", which reflects the carbon intensity of the total fuel mix at any given time. Improvements in energy efficiency principally affect the first of these components, delivered energy, and this is accordingly the main focus of our report. However, the impact upon carbon equivalent emissions remains the ultimate measure of energy efficiency.

2.45. If follows that any gains in energy efficiency could be either nullified or enhanced, as the case may be, by changes in the carbon intensity of the fuel mix. This could be as a result of fuel switching—for instance, from coal to gas, or from fossil fuels to renewables or nuclear power—or through changes in the efficiency with which existing fuels are converted into useful power or heat.

2.46. The impact of such changes in the fuel mix was vividly demonstrated by the announcement on 21 March of the final figures for United Kingdom emissions in 2003. These revealed an increase in overall greenhouse gas emissions, particularly CO_2, largely as a result of increased use of coal for electricity generation, which more than offset improvements in energy efficiency across the economy as a whole.[23] In fact United Kingdom CO_2 emissions in 2003 were just 5.6 percent below the 1990 level, compared with a national target for a 20 percent reduction by 2010.

2.47. The then Defra Minister, Lord Whitty, described this rise in carbon emissions as a "blip", and "not a long-run tendency", noting that the rise in emissions was caused by a "change in electricity sourcing" rather than a long-term rise in energy consumption (Q 716). Insofar as this is true, the increased use of coal is simply a partial reversal of the "dash for gas" in the 1990s, in itself a one-off event which saw the contribution of coal and oil to the electricity generation fuel mix fall from around three quarters to around a third—and which, indeed, played a major part in the United Kingdom's success in reducing greenhouse gas emissions to below the levels set by the Kyoto Protocol.[24] The Minister's argument thus cuts both ways.

2.48. We have not addressed issues such as the efficiency of large-scale power generation, though we have touched on the role that more efficient combined heat and power plants might play in achieving the Government's objectives. Nor have we addressed issues such as the extraction and transportation of primary fuel, or the losses from transmission and distribution systems. Looking forward, nuclear power is currently scheduled to be phased out by around 2025, despite media speculation over its future. There remain doubts over the likely contribution that renewable energy sources will make to electricity generation, and over the extent to which carbon sequestration will

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23 See the Statistical Release by Defra, 21 March 2005: www.defra.gov.uk/news/2005/050321a.htm.

24 See Dr Sinclair's paper, Table 4, which reveals a fall in the carbon intensity of the electricity generating mix of around 25 percent from 1990-1995, corresponding to an absolute drop in emissions of almost 20 MtC, some two thirds of the absolute total fall in emissions since 1990.

be implemented to reduce emissions from fossil-based electricity generation. Major technological innovations that would offer large-scale, cheap, environmentally benign electricity (such as nuclear fusion) remain in all probability some decades ahead, even on the most optimistic predictions. Therefore efforts to reduce emissions cannot be relaxed, and the risk remains that changes in the carbon intensity of the fuel mix will undermine any improvements that can be achieved by means of end use energy efficiency.

2.49. **We welcome that fact that the United Kingdom remains on track to meet its Kyoto obligations. However, as the emissions data for 2003 show, there is no cause for complacency or self-congratulation—the Government have themselves conceded that the domestic targets contained in the Energy White Paper are unlikely now to be met. In fact the United Kingdom had already met its Kyoto obligations before the end of the 1990s, largely for structural reasons and because of changes in the fuel mix, whereas since 1999 carbon dioxide emissions have risen.**

2.50. **Energy efficiency could contribute significantly to future reductions in emissions, and in the remainder of this report we analyse ways in which this contribution can be maximised. However, we believe that in the long term there is no prospect of the Government's climate change objectives being met unless there are also innovations in generating technology, fundamentally changing the carbon intensity of the primary fuel mix. We urge the Government to face up to this issue.**

CHAPTER 3: THE ECONOMICS OF ENERGY EFFICIENCY

Energy efficiency and energy demand

3.1. One of Government's fundamental goals is to promote economic growth and prosperity. For this to be combined with the reduction of greenhouse gas emissions there will have to be a "decoupling" of economic growth from its environmental impacts. Such decoupling was advanced as an objective by both British and Swedish Governments, in the joint letter sent by the Prime Minister and his Swedish counterpart, Mr Persson, to the European Commission in February 2003.[25] The object of this chapter is to analyse some of the arguments underpinning this objective.

3.2. Underpinning the discussion of "decoupling" is the progressive fall in the energy intensity (that is, energy use per unit of GDP) of developed countries. Data provided by the International Energy Agency (IEA), itself established in 1974 in the wake of the oil crisis, show that the ratio of total primary energy supply to GDP (or "energy intensity") in IEA members has fallen by more than a third since 1973.[26] This is presented by some as evidence that "partial decoupling" of energy use from environmental degradation has already occurred.[27] As Lord Whitty said, "we have decoupled in the relative sense quite dramatically on energy and I see no reason why we should not decouple in an absolute sense on energy as well" (Q 710). Figure 6, which derives from the DTI, illustrates the extent of such "partial decoupling" in the United Kingdom since 1970.

3.3. However, while Figure 6 illustrates the changing relationship between GDP and energy use, it does not in itself demonstrate any reduction in environmental degradation. When emissions are added to the equation, the picture becomes more complicated. Figure 7 illustrates the relationship between per capita GDP, energy use and emissions in four countries—the United Kingdom, United States, Australia and Sweden. It reveals significant differences in the relationship between GDP and energy use—indeed, the United Kingdom has the lowest energy intensity of the four. However, there are much more dramatic differences in emissions. Australia and Sweden, for instance, have almost identical per capita energy consumption, but Australia's per capita emissions are almost three times Sweden's. Thus while energy intensity may play a part in "decoupling", the most dramatic gains are likely to be made in addressing the carbon intensity of the fuel mix.

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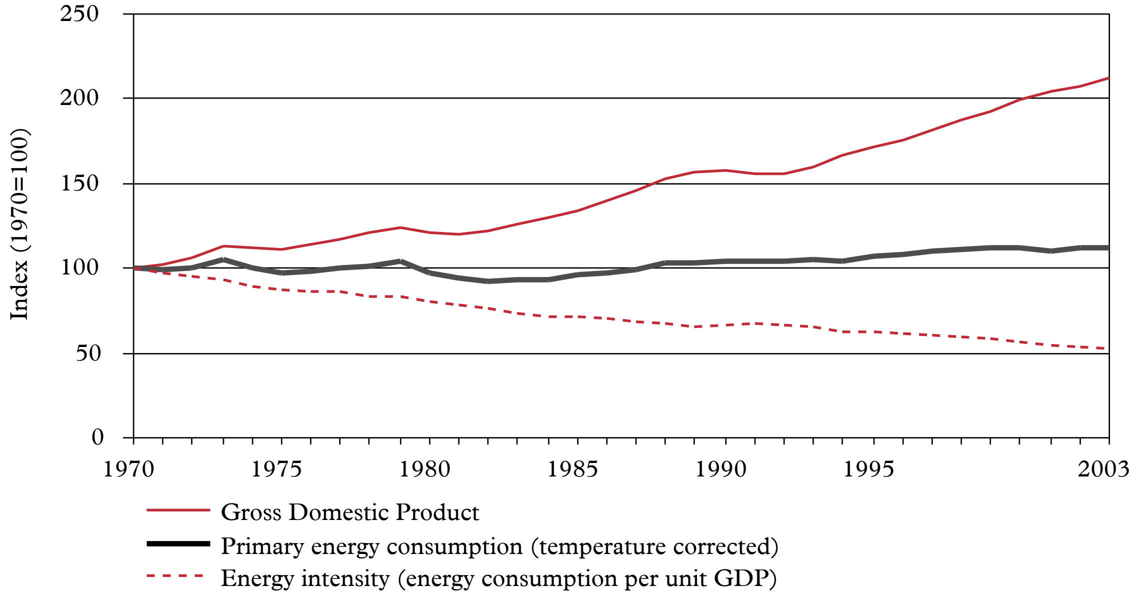
25 See http://www.defra.gov.uk/environment/business/envtech/pdf/blair-persson.pdf.

26 30 Years of Energy Use in IEA Countries, OECD/IEA (2004), p 42.

27 A detailed account of "decoupling" can be found in *Decoupling: Past trends and prospects for the future*, Swedish Environmental Advisory Council (2002).

FIGURE 6

UK energy intensity, 1970 – 2003



Source: DTI, Office for National Statistics.

3.4. Moreover, the nature of the link between energy consumption and GDP is in fact the subject of considerable debate among economists.[28] In particular, there is a school of thought, deriving from the work of the nineteenth century economist Stanley Jevons, which argues that while increased energy efficiency at the microeconomic level may lead to a reduction in energy use, at the macroeconomic level it in fact leads to an increase in overall energy use. This proposition is known as the "Khazzoom-Brookes postulate", after the economists Daniel Khazzoom and Leonard Brookes, who independently published papers putting forward this argument in 1979-80. We received evidence on this debate from a number of sources, including the Institution of Electrical Engineers and A Power for Good Ltd, as well as from Dr Brookes himself.

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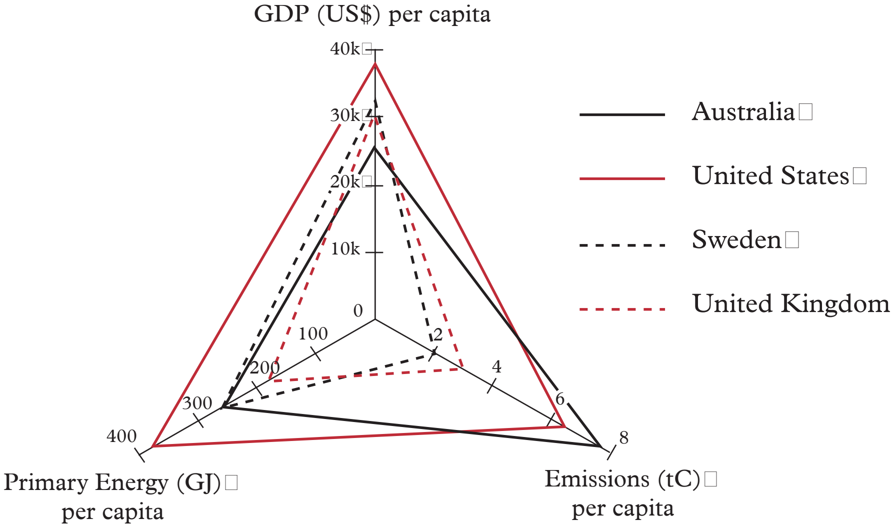
28 For a summary of this debate, see Horace Herring, "*Does Energy Efficiency Save Energy: The Economists Debate*", Open University Energy and Environment Research Unit Report, 74, July 1998.

FIGURE 7

De-coupling: the relationship between GDP, energy use and emissions



Sources: World Bank (2003 GDP and population); IEA (2002 energy consumption); European Commission, US Department of Energy, UK and Australian Greenhouse Gas Inventories (2003 emissions).

3.5. Dr Brookes' argument is that for any resource, including energy, "to offer greater utility per unit is for it to enjoy a reduction in its implicit price". Cheaper energy has two effects: the substitution of energy for other factors of production, which are now relatively more expensive, and the release of income which can then be reinvested in new production capacity, and so on. As a result, Dr Brookes argues, developed countries have, since the Industrial Revolution, seen "rising energy productivity outstripped by rising total factor productivity, hence *rising* energy consumption alongside rising energy productivity".

3.6. A further consequence of this argument is that while rises in the price of energy may stimulate improvements in energy efficiency, such improvements, rather than leading to a lasting fall in energy use, may serve to accommodate the price rise, with the result that energy consumption stabilises at a higher level than it otherwise would.

3.7. The "Khazzoom-Brookes postulate", though it has not been proven empirically, is consistent with classical economic theory, and offers a plausible explanation of patterns of energy use in developed economies. As Professor Paul Ekins, head of the Environment Group at the Policies Studies Institute and co-Director of the new United Kingdom Energy Research Centre (UKERC), told us, "In the economics literature it is … well known that increased efficiency in the use of a resource leads over time to greater use of that resource and not less use of it" (Q 261).[29] This might explain, for instance, why there appears to be no example of a developed society that has succeeded in combining sustained reductions in energy consumption with economic growth. Mr Alan Meier, of the IEA, referred to "several countries

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29 See also the evidence from Mr Paul Spare, who, while accepting that the deduction might seem "counter-intuitive", stated that there was "substantial and varied evidence … to demonstrate that increased efficiency *increases* consumption." (p 338)

that, for brief periods, reduced their electricity consumption or their energy consumption"—often in response to short-term supply crises—but such reductions in demand have never been sustained. This does not mean that sustained reductions in energy consumption are impossible—simply that it is yet to be demonstrated that they are possible. (Q 424)

3.8. We pressed a number of witnesses on the macroeconomic effects of energy efficiency, but did not receive convincing answers. Mr Meier openly admitted that "I always have to retreat to a micro analysis here" (Q 416). Lord Whitty also argued at the microeconomic level, as did his officials, though without Mr Meier's acknowledgement that there might be difficulties in so doing (QQ 717, 9-15). At this microeconomic level, for instance in the case of an individual household, savings that are made through, for instance, improved insulation, release money that will be spent on other goods. These will entail some energy consumption, creating a "rebound effect", but in practice the money that has been released, which was previously being spent essentially on either primary fuel (e.g. gas or oil) or on electricity, is unlikely to be spent on anything equally energy intensive.[30] Absolute reductions in energy consumption are thus possible at the microeconomic level.

3.9. However, this does not mean that an analogy can be made with macroeconomic effects. Apart from anything else, the substitution effects observable at the macroeconomic level cannot be replicated by households, where demand for a range of goods is relatively inelastic. If energy becomes, in effect, cheaper, there is very limited scope for the individual simply to divert money, say from food to energy. A business, on the other hand, could respond to cheaper energy by deliberately increasing consumption—using a more energy intensive process, which would allow savings to be made elsewhere, for instance in manpower.

3.10. We have recently learnt that the UKERC is proposing to commission work on the both the "rebound effect" and the Khazzoom-Brookes postulate under its programme of technology and policy assessments. Results should be available in 2006. While this is welcome, pending the outcome of this work the possibility remains that many of the arguments about the extent of "decoupling" may, at least so far as business and industry are concerned, be fundamentally misplaced. Many improvements in energy efficiency, particularly within industry, are simply products of technical and economic development—investment in new machinery, for example, that optimises productivity across the spectrum, including energy consumption. What the Minister described as the "relative decoupling" of energy use from economic growth may thus simply reflect the fact that greater efficiency in the use of energy is one of the drivers of that growth. We have already noted, with regard to the evidence from Defra, regarding "real relative savings", that savings against a "what might have been" scenario are not real savings at all.

3.11. **The Government's proposition that improvements in energy efficiency can lead to significant reductions in energy demand and hence in greenhouse gas emissions remains the subject of debate among economists. The "Khazzoom-Brookes postulate", while not proven, offers at least a plausible explanation of why in recent years improvements in "energy intensity" at the macroeconomic level have**

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30 A possible exception would be if the money was spent on short-haul air travel; however, this would have to be replicated universally for the "rebound effect" to exceed the original saving.

stubbornly refused to be translated into reductions in overall energy demand. The Government have so far failed to engage with this fundamental issue, appearing to rely instead on an analogy between micro- and macroeconomic effects.

3.12. **We welcome the UKERC project to investigate the "rebound effect" and the empirical basis for the "Khazzoom-Brookes postulate", and recommend that the Government, in parallel with the establishment of a more robust measure for energy efficiency, take full account of the project's progress and results in developing future policies in this area.**

Cost-effectiveness

3.13. A related issue is the Government's use of the term "cost-effective". The meaning of the term is of course dependent on circumstances, time horizons, and so on, but few of these subtleties are reflected in the Government's use of the term. We are all, as individuals and businesses, free to choose where to invest our resources. In the case of a business, for any action to be "cost-effective", it is not enough that it is cheap, or even that it pays for itself over an arbitrary period—one year, say, or five years. Rather, it must represent the optimal use of resources at that moment. This point was forcefully made to us by Dr Brookes:

"Fuel or any other source of energy—and indeed any other economic resource—cannot be used with greater economic efficiency than in a system in which all the resources involved are used with maximum economic efficiency" (p 181).

3.14. It follows that if a business can, by investing a sum of money in energy efficiency, achieve a return on its investment within three years, but by investing the same sum of money in new plant or processes can achieve that return within two years, investment in energy efficiency is not in itself "cost-effective". As Mr Matthew Farrow, of the Confederation of British Industry, said, "it is a competitive world out there", and any proposal for investment "has to be compared against whatever else it can be used for in the business" (Q 572). It is notable that the only period in recent time in which significant reductions in energy use were achieved was the late 1970s, when the economic imperative was enormously strengthened by the oil crises. Significant rises in energy prices today might similarly encourage investment in energy efficiency—but at serious cost to the economy as a whole, and, in the absence of effective measures to reduce the cost to low-income households, to the Government's legally binding commitment to reducing fuel poverty.

3.15. This confusion over cost-effectiveness is typified by the widely reported statement that there is an overall cost-effective potential to reduce energy use by 30 percent. This derives from the 2002 Energy Review[31] by the Performance and Innovation Unit (now the Prime Minister's Strategy Unit), and is repeated in the Action Plan and in the Government's written evidence to this inquiry (p 11). But as Professor Ian Fells pointed out, these savings are simply not being achieved—because, he argued, "they are the technical

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[31] See Annex 6, Table 1 of the PIU *Energy Review*: http://www.strategy.gov.uk/downloads/su/energy/TheEnergyReview.pdf.

potential for saving rather than the economic". Savings that are not "economic" cannot be regarded as "cost-effective".

3.16. On the other hand, there are circumstances in which "cost-effectiveness" may not by itself be an optimal test of investment decisions. In the building sector, for instance, the assessment of cost-effectiveness is distorted by the predominance in this country of "build for sale" development, as distinct from the "build and manage" approach which dominates elsewhere in Europe. This leads the developer to minimise capital expenditure, even where this increases the cost of subsequent occupation of the building. For example, at the point of installation electrical resistive heating is the cheapest form of heating. However, it is associated with both the highest carbon emissions and the highest running-costs, which makes it a significant contributor both to climate change and fuel poverty.[32] The division between the interests of the builder, and the ongoing interests of the subsequent occupants and society at large, means that merely commercial decisions on "cost-effectiveness" are unlikely to be optimal, and Government may have to intervene by means of regulation. Similar issues arise in the rented housing sector, where the economic interest of a landlord is to minimise expenditure on capital and maintenance.

3.17. There are also circumstances in which longer time-horizons are appropriate in making investment decisions. The public sector is subject to rules set out in the Treasury's Green Book, which is based on a 25-year horizon to compare all discounted costs, incomes and benefits. This is intended to avoid perverse decisions based solely on first cost without considering lifetime costs.

3.18. **We recommend that the Government exercise caution in using the potentially misleading term "cost-effective" to describe investment in energy efficiency. They should seek to demonstrate realism as to what is economically achievable by means of private sector investment in energy efficiency.**

3.19. **We further recommend that the Government promote the application of the Green Book guidelines, encouraging decision-makers at all levels, including local authorities, housing associations, PFI projects and other private sector providers to the public sector, to consider lifetime costs in committing expenditure to long-term capital projects.**

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32 22nd Report, *Energy—the Changing Climate*, 2000 (Cm 4749).

CHAPTER 4: POLICY COHERENCE: WHO DOES WHAT

Central Government

4.1. A large number of policy instruments and incentives will be needed to ensure that energy efficiency is effectively promoted. This presents both an opportunity and a risk. If all elements of the chain linking primary fuel extraction to end use of energy can be addressed in a coherent, holistic manner, the potential reduction in greenhouse gas emissions is huge. For this to happen, policies must be comprehensive, but clear and consistent, and in particular avoid duplication, for example in the application of capital grants. On the other hand, if only some aspects of the energy cycle are targeted, or if the policies are confused, there is every prospect that the benefits of localised Government initiatives will be neutralised by losses elsewhere. If policy focused, for example, solely on technical efficiency—low-energy appliances, better insulation, and so on—any energy gains could be dissipated elsewhere in the cycle, for instance, through behavioural changes, such as consumers taking advantage of lower energy bills to install heated conservatories and so on.

4.2. A further problem is that energy efficiency is, in the words of the Energy Saving Trust (EST), "very low down the list of priorities for most people, so low that it is frequently not a factor in the choice of a purchased item and rarely motivates discretionary investment". The EST's conclusion was that no one approach will overcome this apathy—rather, a "range of policy instruments will be needed" (p 119). In other words, a diverse but co-ordinated mix, described by participants at our seminar in October 2004 as "carrots, sticks and sermons".[33] This must include incentives (for example, capital grants, differential VAT rates or eco-taxes, which have been used successfully in Sweden and Germany), regulatory requirements and penalties (notably building regulations), and better information for energy users. In the longer term new technologies will play an increasingly important role, and we consider research in Chapter 11.

4.3. Our inquiry has demonstrated that there is no shortage of activity and of policy initiatives regarding energy efficiency: the question is, is this activity effectively led and co-ordinated? Are all the Government's initiatives pulling in the same direction?

4.4. At the highest level there is a fundamental problem of leadership. In the course of our inquiry it appeared clear that Defra led on energy efficiency, and we heard evidence from the then Minister for Sustainable Energy in Defra, Lord Whitty. Following the election the Government, along with an ill-fated attempt to rename the Department of Trade and Industry as the "Department for Productivity, Energy and Industry", announced the appointment of a new Energy Minister within that department, Malcolm Wicks MP, with responsibility for "secure, sustainable and affordable energy".[34] Unlike his predecessors, Mr Wicks was not to be responsible for e-commerce and postal services, and his appointment therefore appeared at first sight to fulfil our recommendation in *Renewable Energy: Practicalities*,

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33 This phrase is the title of a report commissioned by Defra from Demos and Green Alliance in 2003: see http://www.green-alliance.org.uk/publications/PubCarrotsSticksSermons/.

34 See http://www.dti.gov.uk/about_dti_ministers.html.

that there should be a Minister of State with sole responsibility for energy policy.[35]

4.5. However, by 16 May Defra ministerial responsibilities were announced, revealing that Mr Elliot Morley, the Minister responsible for Climate Change and Environment, would be in charge of "energy issues (including energy efficiency", while Lord Bach, as part of his overall responsibility for Sustainable Farming and Food, would be responsible for non-food crops, including biomass. With this fragmentation of those aspects of energy policy on which Defra has led hitherto, it is by no means clear who will provide leadership on energy efficiency in future.

4.6. Nor are DTI and Defra the only departments with an interest in energy policy. The Department for Transport is vital, and its Secretary of State was a co-signatory to the Climate Change Programme. Building regulations, a key area in energy efficiency, are the responsibility of the Office of the Deputy Prime Minister, while the use of the tax system to provide incentives to investment is a matter for the Treasury.

4.7. A further complication is created by the fact that the promotion of energy efficiency is devolved to the administrations in Scotland, Wales and Northern Ireland (though the latter is currently suspended). A useful summary of the responsibilities and actions of the devolved administrations is provided in the Action Plan, pages 54-58.

4.8. How well are these various activities co-ordinated? Responsibility for co-ordination lies with the Sustainable Energy Policy Network (SEPN), which brings together policy-makers from across the departments and devolved bodies with an interest in energy, and is chaired jointly by the Secretaries of State at Defra and DTI. We have already, in our report *Renewable Energy: Practicalities*, expressed our doubts as to the effectiveness of SEPN, and recommended instead the appointment of a single Energy Minister, bringing together the responsibilities currently shared between these two major departments.

4.9. That recommendation was rejected by the Government, and was again resisted by Lord Whitty in his evidence to this inquiry. He not only argued that SEPN had "done a pretty effective job so far", but suggested that the issue of departmental responsibility was one "we can become too obsessed by". He noted that even when there was a separate Department of Energy some aspects of energy policy ("whole swathes of transport and buildings") fell outside that Department. He also noted that the recently constituted Swedish Ministry for Sustainable Development, which brings together responsibility for both the Defra and DTI aspects of energy policy, still did not cover transport, which accounts for over a quarter of energy use. In short, there was always going to be a "boundary line somewhere"—the key issue was "clarity of direction" (QQ 705-706).

4.10. Some other witnesses were less sanguine. The British Cement Association (BCA) said that "it is imperative that public policy is overseen, co-ordinated and guided from one point, rather than being scattered through a variety of government departments, each with differing agendas and priorities" (p 202). In oral evidence Mr Mike Gilbert, the BCA's Chief Executive, went further, accusing ODPM, Defra and DTI of "all pulling in different

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[35] *Renewable Energy: Practicalities*, paragraph 2.18.

directions in terms of energy policy, particularly energy efficiency in building" (Q 599). Professor Ian Fells of Fells Associates also argued that "more joined up policy is required, having energy under both the Defra and DTI banners does not help matters" (p 290). Martin Wyatt, Chief Executive of the Building Research Establishment (BRE), noted that the construction industry is "regulated, leant upon, involved with, 13 departments across government now. There is no focal point at all" (Q 502).

4.11. We note, moreover, that Lord Whitty himself, following his retirement from the Government at the General Election, appeared to accept the need for greater clarity in energy policy. In the course of a debate on our report *Renewable Energy: Practicalities* he said, "we have not yet got complete cohesion in government on the matter … I do not normally argue for changes in government structure to achieve a change in government policy, but, in this context, I think that, despite the relatively good co-operation involving Ministers in the energy field, we need a more focused structure".[36] We agree.

4.12. Uncertainty over departmental responsibility is reflected in the diversity of policies, programmes and agencies. National Energy Action described current institutional arrangements as an "obstacle" to energy efficiency: "The plethora of different schemes, each with varying qualifying criteria, offering a different range of measures, and sponsored by different private and public bodies, is … a source of confusion". Professor Oreszczyn confirmed the point:

> "In terms of institutions and instruments, we have the Energy Saving Trust, The Carbon Trust … and Part L of the Building Regulations … We have had regular rebranding of schemes with similar goals—Home Energy Efficiency Scheme then Warm Front, Energy Design Advice Scheme and now Design Advice. In research we currently have the Carbon Visions programme, Tyndall Centre and the UK Energy Research Centre. This is confusing to both professionals and the public" (pp 70-71).

4.13. When we visited Leicester we were given a striking example of the effect of such institutional fragmentation. The Council has sought support for the development of a biomass generator for the city's district heating network from both the Energy Saving Trust and East Midlands Development Agency. The Agency's initial refusal to support the project, and the time that would have been taken in resubmitting the proposal, meant that the Council were unable to meet the deadlines set by the Trust, with the result that the project stalled. We understand that at the time of writing the Council is considering the possibility of securing funding from the private sector.

4.14. Can the delivery of policy be simplified? The most obvious first step would be to combine the Carbon Trust, which promotes energy efficiency within the industrial, commercial and public sectors, and the Energy Saving Trust, which deals with domestic energy efficiency. The Carbon Trust itself acknowledged that there were "areas of overlap" between the two bodies, particularly where small businesses, operating in what were in effect domestic premises, were concerned. The Trust accepted that the idea of a "one-stop shop" was "intuitively appealing", and could produce "some synergies and cost benefits", but warned of a possible "loss of focus" if the two existing

[36] HL Deb, 23 June 2005, col. 1798.

bodies were replaced by one larger organisation. Andrew Warren, Director of the Association for the Conservation of Energy, on the other hand, said, "We simply do not see why we need two different agencies … There is no need to have two ways of telling the time." We agree, and believe that the benefits of having a single organisation would outweigh the risk identified by the Carbon Trust (p 55, Q 117).

4.15. **The Government assert that the Strategic Energy Policy Network (SEPN) ensures effective co-ordination across Departments and agencies. The evidence we have heard does not bear this out. While there will inevitably be boundaries between different departmental responsibilities, the way these are currently set is a recipe for confusion. We therefore recommend once again that the Government bring together responsibility for those aspects of energy policy currently handled by Defra and the DTI under a single Energy Minister. We believe this to be a necessary first step if the wide range of policies and agencies in the energy field are to be rationalised and effectively co-ordinated.**

4.16. **We believe that the existence of two agencies promoting energy efficiency risks overlap and confusion. We therefore recommend that the Carbon Trust and the Energy Saving Trust be merged.**

Local Government

4.17. Many of the most impressive initiatives that we have witnessed in the course of our inquiry have been the result of "bottom-up" local action. In Leicester the City Council in 1990 set a target to reduce the city's emissions by 50 percent by 2025. Since that time the city has, for instance, upgraded the city's 50-year-old district heating scheme; invested in solar power; installed a data collection and management system to allow real-time monitoring of energy consumption; and opened an Energy Centre for local businesses and people. In the course of our inquiry into renewable energy in 2003-04 we visited Woking, where the local council has a similarly impressive list of achievements.

4.18. However, Leicester and Woking, though not unique within the United Kingdom, are certainly exceptional—although the investment required for their initiatives is allowed under "invest to save" rules, and both Councils have in addition benefited from one-off grants, few other local authorities have been as enterprising—indeed, Elizabeth Wilson, of the Planning Officers' Society and Local Government Association, argued that existing guidance on "Invest to Save" rules "needs to be disseminated better" (p 312). In both Leicester and Woking, progress has been achieved thanks to consistent, local cross-party support, and to the passionate commitment of Council staff—who in both cases commented on the lack of central Government support, and the handicaps faced by local authorities, for instance in not being able to run local utilities. In marked contrast, Durham University, where the Vice Chancellor and his staff have made every effort to improve the energy efficiency of the estate, has had little or no support from the local authority.

4.19. We saw a very different culture in Germany and Sweden, one in which local authorities are much more proactive. The city of Berlin, for instance, has some 6,000 public buildings, with annual energy costs of €250 million, and annual emissions estimated at 0.8 MtC. The Berlin government created the

Berlin Energy Agency in 1992 as a public-private partnership, involving the energy supply company Bewag, and the state-owned bank KfW. Through the Agency, private third parties bid to manage the energy requirements of, on average, around 20 buildings. They take on all the initial investment costs involved in modernising systems and services; in exchange they take 70-90 percent of any savings realised over a contract period of 10-15 years. As a result of the scheme the city has achieved savings of around €9 million, and CO_2 emissions have been reduced by 100,000 tonnes annually.

4.20. In Sweden the tradition of private enterprise at local level is equally strong. The city of Gothenburg, for example, owns the local energy company, Göteborg Energi, which generates and distributes heat via a 700 km district heating network. Its largest customer, the municipal housing association Poseidon, owns 23,500 apartments, and has overseen a fall in energy consumption across its properties of some 15 percent.

4.21. Swedish central government has also acted as sponsor of innovative local projects, through its Local Investment Programme (LIP, now renamed the Climate Investment Programme, KLIMP). According to Professor Thomas Kåberger, who was commissioned to evaluate the programme, the key to its success was the way it stimulated dialogue between municipalities and local industry. Under the LIP, applications for grants were invited to support innovative projects meeting a range of environmental and social objectives. Government funding represented about 20-30 percent of total cost, and the programme as a whole cost some £500 million over the duration of the programme. The resulting projects had delivered emissions reductions at a cost of approximately £10 per tonne carbon, and jobs at a cost of around £130,000 per permanent job.

4.22. The United Kingdom does not have the same tradition of local independence and enterprise. Nevertheless, on 17 March the Local Government Association, together with other similar associations across Europe, launched "8 messages for the G8 and EU", arguing that "local authorities must be given the tools to change energy consumption patterns and promote awareness of how people can tackle climate change in their everyday lives."[37] This campaign is particularly pertinent given the British Presidencies of both G8 and EU in 2005.

4.23. **Local authorities are in many cases better placed than central Government to bring together local people and industry in developing innovative projects to promote sustainability and energy efficiency. However, there is no consistency of approach across local authorities, while the successes of authorities such as Leicester and Woking appear to have been if anything hindered rather than helped by central Government. We therefore recommend that the Government both make more effort to disseminate the existing "invest to save" rules, and explore new ways to promote dynamic local action in pursuit of its energy policy goals. In particular the Government should consider the model of the Swedish Local Investment Programme, as a highly effective means to kick-start local initiatives.**

[37] See http://www.lga.gov.uk/PressRelease.asp?lSection=0&id=SXC593-A782CE00. The text of the "8 messages" can be found at http://www.ccre.org/img/8_message_final.pdf.

The European Union

4.24. The EU plays a crucial part in the United Kingdom's energy policy, both through the growing framework of European legislation and through providing funding for research, social programmes, and so on. A summary of EU legislation relevant to energy efficiency can be found in a recent Report of the House of Lords European Union Committee,[38] and we have therefore not duplicated the work of that Committee by analysing EU legislation as such. We shall in later chapters address particular issues in detail, such as the EU product labelling scheme, the Energy Performance of Buildings Directive, which will come into force next year, and the proposed Energy Services and EcoDesign for Energy Using Products Directives. We shall also touch on EU matters in considering the issue of differential VAT rates for energy efficient appliances and for building refurbishment.

4.25. At this stage we merely offer the following general observations, derived largely from our discussion with Mr Meier, of the IEA. As he pointed out, in the field of energy efficiency as in other areas, the EU "potentially has a tremendously powerful role", but is largely dependent on individual member states not only to formulate but to implement legislation—the EU institutions themselves lack the staff, expertise and procedures for effective, detailed implementation and enforcement. The result is a degree of variation between member states, some of which "have pursued more aggressively the implementation of the energy efficiency policies inside Europe and have tried to complement the implementation of those with other policies that make them more effective". The implication is that some other member states have been less enthusiastic, and that implementation of EU legislation across the Community has been patchy (QQ 407, 404).

4.26. **The European Union is already influential in the field of energy efficiency, and is likely to become still more influential in future. We look to the Government to ensure that the United Kingdom uses the opportunity presented by its forthcoming Presidency to promote best practice, negotiating effective, enforceable legislation where appropriate, and at the same time ensuring that the principles of subsidiarity and proportionality are respected.**

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38 European Union Committee, *The EU and Climate Change*, 30th Report, Session 2003-04 (HL Paper 179-I), p 43.

CHAPTER 5: BEHAVIOUR

Introduction

5.1. In Chapter 2 we summarised the various kinds of inefficiency or waste occurring as primary energy sources are converted into useful outputs. At each stage there are barriers which will have to be overcome if overall energy use is to fall. However, the final stage, that of the behaviour of the consumers of energy, is arguably the most important and the most complex. In this chapter we shall focus for the most part on individual behaviour, particularly within domestic households—though many of the conclusions we reach can be applied by analogy to commercial or business environments. Indeed, as the Government acknowledge with respect to the business sector, "in the 1980s we thought that the barriers for uptake of energy efficiency measures … were largely technical and economic … we now know that organisational and behavioural barriers are equally important." (p 11)

5.2. What is true of business behaviour is still more relevant with regard to individual behaviour, where the commercial motivation that should, other things being equal, inspire economically rational behaviour, is much weaker. As Professor Paul Ekins told us, "Clearly people could change their behaviour and save energy in all sorts of ways which would not require any investment at all, but behaviour is a very complicated business and we all behave in the way that we do for quite good reasons as far as we individually are concerned." This leads into what Professor Ekins called a "very rich area of social science", concerned with the "interplay between incentives and regulations, and about actually knowing how people will behave when certain actions are taken" (Q 261).

5.3. Within this field a particularly striking demonstration of the potentially perverse and unintended behavioural consequences of energy efficiency was mentioned in Professor Oreszczyn's written evidence, and described by him in more detail in his presentation to our seminar in October 2004. It was originally envisaged that domestic conservatories would reduce the energy consumption of houses, by providing an unheated buffer space around the outside wall—in effect, an extra layer of insulation. However, in practice this simply has not happened. Householders want to use their conservatories all year round, and so install heating in these highly inefficient spaces, or open them up to indoor rooms, to the extent that 90 percent of conservatories are now directly or indirectly heated, adding hugely to domestic heating bills. Furthermore, the average energy consumption for double glazed conservatories is in fact higher than that for less energy efficient single glazed conservatories—the explanation being, that customers who wish to sit in the conservatory all year round will buy double glazing.

5.4. Another example of perverse consequences was given by the Economic and Social Research Council, who noted that the microwave had "largely become a device for defrosting and reheating food". This has "contributed to the demand for frozen and prepared foods; this in turn is highly energy intensive in its production, distribution and storage". The ESRC's conclusion was that "by focusing exclusively on energy use policy-makers have failed to pay anything like enough attention to the services and practices that energy consumption makes possible". Professor Oreszczyn's conclusion was in essence similar: "We appear to have an almost innate ability to come up with new and novel ways to use energy even if we know it is bad for the planet" (pp 322, 73).

5.5. The unpredictability of human behaviour is thus at the root of many discrepancies between theoretical efficiency, particularly of buildings, and actual energy performance in use. Faced with this, Government have various strategies at their disposal, and the Government's written evidence draws attention to the following:

- Regulation (this is a matter of compelling rather than influencing behaviour, and is therefore considered in later chapters);
- Incentives and penalties;
- Education and exhortation;
- Provision of better information on actual energy consumption.

Incentives

5.6. The most obvious incentives are economic—in the Government's words, "the potential to save money on fuel bills". The drawback is that even when investments are fully cost-effective, with short payback times, it has proved extremely difficult to overcome what the Cavity Insulation Guarantee Agency describe as "customer apathy" (p 273). The difficulty is much more extreme when the investment is greater, and the payback time longer. In the words of United Utilities: "Rational behaviour would see individuals looking at whole life costs of their investments, when replacing a boiler, installing double glazing or cavity insulation. The reality of course is that few individuals behave in this way" (p 341).

5.7. Reasons for this market failure are not hard to find. Perhaps the most obvious is energy's very low profile for most consumers: as the Government note, "for most consumers energy represents a very small proportion of their overall expenditure: in households typical bills are around £600 per year, less than their spending on alcohol". For most businesses, energy costs are "typically 0.5-1 percent of turnover" (p 9). Payback times for what can in some cases be substantial capital investment are correspondingly long.

5.8. But while low prices may have contributed to careless use of energy, there is no guarantee that higher prices would have the reverse effect. As the Energy Saving Trust note, "the propensity of consumers to invest in … energy efficiency is not very price sensitive" (p 119). Energy demand is in itself relatively inelastic—the bulk of energy is used for core tasks, such as heating and hot water, and while there are significant savings to be achieved, for instance by turning down thermostats, the link between such actions and ultimate economic savings is under current conditions far from clear to most consumers.

5.9. Furthermore, an across-the-board increase in energy prices would, unless accompanied by a highly effective programme of social welfare, have a disproportionate impact on the fuel poor (that is, those who spend above ten percent of household income on fuel).[39] It could also have a disastrous impact upon industry, where energy prices have already risen markedly, and are already subject to targeted taxation—in the words of Dr David Harris,

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39 This is the definition of fuel poverty used in the White Paper (p 107)

Secretary General of the Aluminium Federation, "you cannot keep taxing industry and expect it to stay in the UK" (Q 601). We do not therefore believe that generalised energy price rises would in themselves be a desirable way to promote energy efficiency.

5.10. However, various targeted economic instruments have been proposed. The EST, who are currently researching fiscal incentives, argued that "Government must signal further fiscal measures to encourage consumers to save energy". The Royal Society agreed: "placing primary emphasis on well-designed economic instruments can provide considerable motivation and incentive across the industrial and domestic sectors" (p 327). Fiscal incentives for domestic households that were discussed in the course of our inquiry included "green" or carbon taxes, rebates on property-related taxes such as Council tax or stamp duty, or an extension of the existing carbon trading arrangements from industry to households or individuals. Industry and business (including landlords) can also benefit from the Enhanced Capital Allowances scheme. Finally, we consider in this section the development of a market for energy services, along with revised pricing structures that would promote lower energy use.

Carbon taxes

5.11. Carbon taxes have a long track record in Sweden, where a "green tax shift" was initiated in 1991, with progressive increases in targeted energy taxes being counter-balanced by reductions elsewhere, such as in payroll and income taxes, so as to produce overall a revenue-neutral result. In Sweden green taxes apply across the board, and have succeeded in shifting some SKr 8 billion (around £600 million) to "green taxes" by 2003.[40] At the same time, Sweden's success in promoting energy efficiency and renewables is well documented.

5.12. The closest analogy to a carbon tax in the United Kingdom is the Climate Change Levy, a tax on energy paid by industry, which was introduced in 2001, though this excludes both households and transport. It is also payable not just on fossil-fuelled power, but on some carbon-free sources, notably nuclear, so that its impact upon carbon emissions is far from clear. We shall consider the Levy, and related instruments affecting industry such as Climate Change Agreements, in more detail in Chapter 10

5.13. However, a carbon tax, like a general increase in energy taxes, would inevitably have a regressive effect. Professor Ekins, who co-authored a Policy Studies Institute report on ways to mitigate this effect, noted that "if you simply levied the carbon tax in an undifferentiated way across households … you would make low income households disproportionately worse off". However, his research suggested that if the revenue generated was redistributed through the benefits system "80 percent of these households ended up better off". However, he conceded that this still meant "that 20 percent of [low income] households were made worse off", thus deepening fuel poverty. He concluded that until this issue could be addressed a carbon tax would remain a "relatively unpopular" measure (Q 271).

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40 See *Energy Policies of IEA Countries*: Sweden: 2004 Review, IEA/OECD, pp 30-36.

Enhanced Capital Allowances

5.14. While rising energy prices or carbon taxes would influence ongoing expenditure on energy or fuel, Enhanced Capital Allowances, which were introduced by the Government in 2001, are designed specifically to influence decisions on capital investment in new plant and machinery. The scheme allows any business that pays Corporation Tax to offset the capital cost of new, energy efficiency machinery, against its taxable profits. Qualifying plant or machinery is listed in an Energy Technology List, which is regularly updated by the Carbon Trust.

5.15. The ECA scheme appears in practice to have had a limited impact. The Environmental Industries Commission noted that the financial advantage represented for most companies a "relatively modest incentive", and recommended that the allowance be increased to 150 percent of the capital cost. The Carbon Trust also noted that for smaller companies, particularly those making little or no profit, the value of the ECA was insufficient to tip the balance in favour of energy efficient equipment. Public sector organisations, which do not pay Corporation Tax, are ineligible for the ECA—although the Action Plan noted that good practice was encouraged by the Office of Government Commerce "OGCbuying.solutions" website, which provides advice on procuring environmentally friendly equipment. The EIC, however, drew attention to the lack of control over Private Finance Initiative contracts, where private sector companies are more likely to go for the lowest cost option (compare paragraph 3.16).

5.16. The Carbon Trust also suggested that the Government might "simplify some of the procedures by which technologies qualify for an ECA", citing lighting as an example. At present companies can claim the ECA in respect of energy efficient lighting only if the lighting qualifies as "plant"—in other words, to quote from the Inland Revenue website, "A complete lighting system may be treated as plant … if the system is provided mainly to meet the particular requirements of the trade carried on in the building in which the system is installed". However, general lighting that would be necessary within the building regardless of the kind of business being carried on there would not qualify.

Council Tax or Stamp Duty rebates

5.17. An alternative approach to household emissions is to offer rebates on particular property-related taxes such as Council Tax and stamp duty in exchange for the installation of energy efficiency measures.[41] British Gas have recently initiated a pilot scheme, in partnership with Braintree Council in Essex, in which £100 reductions in Council Tax are offered in return for the installation of energy efficiency measures. Although the results are not yet known, Mr Patrick Law, Director of Corporate Affairs at British Gas, was optimistic, noting that other Councils had expressed interest, and that Braintree had not had to market the scheme very heavily to excite interest. The key was to provide an incentive that was "framed in a compelling way" (Q 371).

5.18. There also appears to be growing momentum behind the campaign for a stamp duty rebate, which was endorsed by the Energy Saving Trust and the

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41 See written evidence from the Association for the Conservation of Energy, and from the Cavity Insulation Guarantee Agency.

Association for the Conservation of Energy (pp 121, 59). In a report published in March the Green Alliance made a similar recommendation, suggesting that stamp duty rebates should be developed in tandem with the introduction of Home Information Packs in 2007, which will also include the energy performance certificates required by the Energy Performance of Buildings Directive. Green Alliance also pointed out that stamp duty had "the added attraction of being levied at the point of house sale/purchase, a time when the seller and/or purchaser often carries out other improvement work and when the house (and loft) is empty".[42] As property in the United Kingdom changes hands, on average, every seven years, over time such an approach would cover a large majority of privately owned properties.

5.19. However, while this proposal has its attractions, we note various potential difficulties: for instance, because stamp duty only bites when properties change hands (unlike Council Tax), a significant proportion of householders would not be affected by rebates for the foreseeable future. Also, those who acquired a highly efficient property would have little or no scope to benefit from rebates, while, given variations in property prices and stamp duty levels around the country, great care would have to be taken to ensure that the prospective rebates were equitable and effective.

Domestic Tradable Quotas

5.20. A still more radical proposal is to introduce a "domestic tradable quota" (DTQ) for each individual, analogous to the carbon emissions quotas already allocated to industry under the EU and UK Emissions Trading Schemes. The proposal was advanced at our seminar by Dr Brenda Boardman, of the Environmental Change Institute in Oxford, and in evidence by Richard Starkey and Kevin Anderson, of the Tyndall Centre in Manchester, who are conducting a study of the scheme's practical feasibility, and by Ms Tina Fawcett and Dr Mayer Hillman.

5.21. The argument for DTQs relates to the "contract and converge" model for a possible successor to the Kyoto Protocol. According to this model agreement must be reached, with a view to avoiding unacceptable climate change, on the maximum allowable concentration of greenhouse gases in the atmosphere, and on the basis of this agreement it would be possible to work out how much emissions will have to be reduced and over what timescale. These overall figures would then be converted into equal *per capita* shares, which would be assigned to individuals as personal, tradable carbon allowances. Over a period of, say, 20 years, personal allowances would decline until such time as the point of convergence had been reached.

5.22. The fundamental problems for DTQs are practical: we simply do not believe that individual carbon trading is feasible within the foreseeable future. Even Mr Starkey conceded that there were "definite implementation issues", both in terms of the "enrolment of fifty million people" and in the information technology challenge of monitoring and enforcing carbon quotas. Furthermore, the "contract and converge" model, which underpins DTQs, is far from universally accepted—it is by no means clear if and when the international community will reach agreement on what is to follow Kyoto. Application of *per capita* allowances to individual households, irrespective of variables such as income or the type of dwelling, could also raise serious

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42 *New policies for energy efficiency*, Green Alliance/Business Council for UK, March 2005, p 13.

issues of equity. We therefore do not see DTQs as a practicable option within the foreseeable future.

Energy Services

5.23. In the longer term, the development of a strong market in energy services will be crucial in changing the relationship between consumers and energy suppliers. At present, the suppliers are obliged, under the terms of the Energy Efficiency Commitment (EEC), to deliver specified carbon savings in proportion to the number of their customers—for instance, by supplying home insulation or condensing boilers. For each such product the company receives an energy saving credit, which is finally presented to the regulator. However, despite this final balancing EEC comes at a cost to the supply companies, both in reduced demand for energy itself, and also because the assumed cost of the programme, estimated by Defra at £8.97 per customer per bill, may underestimate the real cost to the companies themselves (Q 347). In addition, companies face the risk that, under the terms of the present liberalised energy market, customers, having reaped the benefits of subsidised energy efficiency products, may with just 28 days' notice terminate their contract and change suppliers.

5.24. The development of a market in energy services, currently the subject of a DTI pilot scheme, is intended to mitigate this last risk. According to this model, longer-term contracts, combining energy supply with wider energy-related services, will be permitted. Mr Law, of British Gas, gave us one example: the company will offer free insulation in exchange for a contract according to which the consumer will pay nine percent higher energy charges. The increase in the customer's bill (typically about £60) will be outweighed by the saving as a result of the insulation (about £90)—in other words, the up-front capital cost is met out of the ongoing saving (Q 368).

5.25. Thus the development of energy services, which are also being pursued at European level through the draft Energy Services Directive, could offer entirely new business opportunities to the energy companies—as Mr David Sigsworth, of Scottish and Southern Energy, told us, "the actual business of reducing energy will drive new profit streams … that has to be big business if energy efficiency targets are to be met" (Q 370).

Tariffs

5.26. Finally, we turn to the pricing of energy. At present the prevailing model in energy as in many other sectors is that prices fall as consumption rises. Although we have received no evidence specifically addressing this issue, we see no reason why this model, which appears to create a perverse incentive to be less careful about energy the more one uses, should not be challenged. So-called "lifeline" tariffs were introduced in many American states after the oil crises of the 1970s, and provide for cheap electricity sufficient to meet the most basic needs (typically up to around 50-60 percent of average household consumption), and more expensive electricity at higher levels of use. This approach both ensures that electricity for basic necessities is affordable, and encourages conservation at higher levels of consumption. Similar models have been applied by certain states to gas and to water supplies, which like electricity are easily metered.[43]

5.27. A similar approach has been applied in the developing world, providing households with a "free" quota of energy, sufficient for basic needs, while charging them when this quota is exceeded. We see no reason why "lifeline tariffs" should not also be introduced in this country. They have many advantages: they are non-regressive, as poorer households on average use substantially less energy than the better off; they create a strong incentive to cut back on non-essential energy use; and they are transparent and easy to administer.

5.28. Equally, there is no reason such tariffs should not be commercially viable for supply companies. It would of course be essential that the level of the initial quota was set sensibly and fairly. It might also be possible to incorporate a standing charge (analogous to the line rental paid by telephone users), or to combine "lifeline tariffs" with longer-term contracts for energy services.

Conclusions

5.29. **We endorse the view of the Energy Saving Trust, that the Government should urgently review the fiscal incentives to energy efficiency. None of the proposals we have heard appears to be without difficulties, but we look forward to the results of the pilot scheme initiated by British Gas and Braintree Council, which should provide valuable information on the effectiveness of Council Tax rebates.**

5.30. **We look forward to the results of the Carbon Trust's review of the impact of the Enhanced Capital Allowances scheme, and, subject to the results of that review, recommend strengthening the financial incentives for small companies, and increasing use by the public sector of the Energy Technology List. This should include the extension of the requirement to use the List to Private Finance Initiative projects.**

5.31. **We welcome the current energy services pilot scheme. If the results of the pilot are satisfactory we look forward to the extension of the energy services model nationally.**

5.32. **We further recommend that the Government and regulator review current energy pricing arrangements, which create a perverse incentive to consume more energy. In particular, we recommend that the Government explore the feasibility of introducing pricing arrangements based on the model of "lifeline tariffs".**

Education

5.33. The education system will ultimately play a crucial part in increasing awareness of energy use and its associated effects on greenhouse gas emissions. When we visited Leicester, we visited the Eyres Monsall Primary School, where a 2.5 kW wind turbine, the first in Leicester, was installed in December 2004. The children were able to monitor the output from the turbine via computers in the main entrance. More, larger turbines are

[43] We are grateful to Professor Dennis Anderson, of Imperial College, for his written comments on lifeline tariffs.

planned for other schools in Leicester. Such imaginative projects will surely contribute in the coming decades to the growth of a better-informed and more careful generation of energy consumers. While some grants have been made to schools through the "Clear Skies" programme, the current "Building Schools for the Future" programme provides an excellent opportunity to promote such projects more widely. **We recommend that the Government make ear-marked funding available, possibly as part of the "Building Schools for the Future" programme, to finance innovative, energy-based school projects such as those in Leicester.**

5.34. The "education" of the adult population, which is of greater relevance to this report, given the timescales for action set out in the Energy White Paper, is inevitably more difficult. Experience suggests that people generally do not respond satisfactorily to sermons, and that this is true in the field of energy efficiency was repeated by many witnesses. In the words of the Energy Saving Trust, "general exhortation and Government public information campaigns are not very effective on their own" (p 119). The Government drew attention to an "attitude-behaviour gap", suggesting that "information failure is rarely the key problem" (p 9).

5.35. The Energy Saving Trust conducts general campaigns on energy efficiency, as do energy supply companies—producing literature that was described by National Energy Action as "clear, helpful and attractively presented" (p 302). But the key appears to be not just to provide information, but to offer advice that is timely and targeted—in the words of the Energy Advice Providers Group (EAPG), "specific to individuals and their circumstances"—and so more likely to be translated into action. One example of such targeted advice was drawn to our attention in a lecture given on 13 June by Christie Todd Whitman, former Governor of New Jersey and Administrator of the US Environmental Protection Agency, to the Carbon Trust: in the United States simple energy advice is often tied into weather broadcasts—for instance, viewers are told "it is going to be cooler, so you can turn off your air conditioning".

5.36. Are the arrangements for providing targeted, specific advice in place? The picture turns out to be complicated, the sources of advice diverse and variable in quality. National Energy Action drew attention to the results of Ofgem's monitoring of calls made to suppliers, showing that of some 24 million households, only 110,000 were given oral advice on energy efficiency in 2003, some 18 percent fewer than in 2002. Only one enquirer in five was told about EEC schemes for which they would have been eligible. Ofgem is currently seeking to encourage suppliers to ensure that call centre staff are more aware of the opportunities to provide advice on energy efficiency.

5.37. Nevertheless, the supply companies are keen to advertise their ability to offer advice and support. Mr Jon Kimber, of British Gas, told us that the company was "looking at a major redesign of the way that we provide energy advice to consumers. We will be introducing a new product … which will again not just provide advice but will provide an insight into the environmental consequences of … energy use. That will be available through a whole host of different media … it will be available through requesting an energy survey of the home and we will provide data from that energy survey" (Q 374).

5.38. Another source of advice is the Energy Saving Trust, which runs a network of 52 Energy Efficiency Advice Centres around the United Kingdom. These both provide advice to consumers and, crucially, "follow up and see how many consumers actually acted on that advice" (Q 764). The Trust confirmed that it would use the Advice Centres increasingly to direct consumers to offers made by suppliers under the EEC. In addition, in early 2005 the Trust began to pilot a "Sustainable Energy Network" (SEN), aiming to "provide information, advice and support for action locally" (p 121). This network will build upon the existing network of Advice Centres, allowing the Trust to work more closely with regions and local authorities.

5.39. In promoting the value of the SEN, and conceding that "delivery of household energy efficiency will always need to be done locally", the Trust argued that "most local authorities are not well placed to deliver consumer campaigns or technical advice to households. There is therefore a synergy between the community leadership role of local authorities and the advice and project work that the SEN will deliver." In marked contrast, in Leicester we visited an impressive Council-run Energy Centre, which provided a "one stop shop" for local people. We also heard about the Council's information campaigns, including a "Keep Leicester Cool" campaign targeted at ethnic minorities, and local awards schemes. We have already mentioned the Council's projects in local schools. The picture was of dynamic and effective action to raise awareness of energy issues in the local community.

5.40. In addition we heard that in October 2003 the EAPG had established a "Domestic Energy Efficiency Advice Code of Practice", of which the Energy Saving Trust has now taken ownership.[44] The EAPG has commissioned market research into the efficacy of energy advice, confirming the importance of follow-up. It also drew attention to the forthcoming introduction of Energy Performance Certificates, which "will inform a much larger proportion of householders about the possibilities of improving the energy efficiency of their homes". We discuss Energy performance certificates in more detail in Chapter 6. At this point we simply agree with the EAPG's comment that this opportunity to provide good, targeted advice "must not be missed".

5.41. **There are currently too many possible sources for energy efficiency advice; the quality is inconsistent, and follow-up patchy. We welcome the efforts of the Energy Saving Trust and Energy Advice Providers Group to bring coherence to the field.**

5.42. **However, we believe that local authorities, particularly if they are able to assume the more proactive role in promoting energy efficiency that we have already recommended, are likely to be best placed to provide impartial advice tailored to the needs of local consumers. We recommend that the new Sustainable Energy Network be developed in such a way as to promote best practice, while ensuring that the responsibility for delivering advice is devolved to local level.**

5.43. **Wherever possible energy efficiency advice should be tied to firm data so as to produce specific recommendations for action. Energy supply companies are to an extent already offering such a service by means of energy surveys. The introduction of Energy Performance Certificates will offer an ideal opportunity for local authorities to target advice more effectively.**

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44 Details are available on the website www.goodenergyadvice.org.uk.

Energy use data

5.44. While advice and information proliferates, and while appliances are routinely labelled with detailed figures on efficiency and overall energy consumption, most consumers have no access to data on their own energy use. Meters are often inaccessible and difficult to read. Supply companies offer discounts to consumers who pay for energy by direct debit, calculated by reference to average consumption rather than real energy use. Bills themselves are uninformative, frequently based on estimated readings, rather than real data, and lacking points of reference or comparison.

5.45. To some extent the Government have already confronted this issue:

There is growing recognition that the provision of better information to consumers can lead to energy savings. A desk study carried out for Ofgem, based on evidence from overseas, concluded that sustained savings of 5-10 percent could be achieved by presenting clear historical information on bills … Defra, DTI and Ofgem, under the auspices of the Joint Working Group on Energy and the Environment are currently reviewing the evidence and options for action (p 10).

5.46. This is a welcome development. Comparative data on energy consumption, degree-day adjusted, are already provided on bills in countries such as Norway, and there is no technical reason why they should not be supplied here. Indeed, as well as providing data on current and historical energy consumption, bills could readily give other comparisons—for instance with best, average and worst performance for particular types of dwelling. **We recommend that the Government, together with the regulator, not only press forward their review of the presentation of information on bills, but that they specifically explore innovative ways in which information can be presented so as to exert the greatest possible influence on behaviour.**

5.47. However, there is more to be said on this issue. The technology to enable remote meter-reading is now readily available, and would allow suppliers to access meter information without having to enter properties, thus avoiding the need for estimated readings. While there would be a significant capital cost associated with introducing remote metering, there would be ongoing savings in the potential to automate meter-reading, avoiding the need to employ staff to take readings.

5.48. "Smart" metering presents still greater opportunities. A simple smart meter could be a display unit on, for example, the kitchen wall, which would receive signals transmitted from the gas and electricity meters, and convert them into a simple measure of current energy consumption. Consumers would thus be able to keep track of their energy consumption in real time, and in a variety of units—for instance, in financial terms, or in terms of carbon equivalent emissions.

5.49. As long ago as 2001 the DTI set up a "Smart Metering Working Group", and in September of that year the Group reported that small scale demonstrations suggested reductions of 5-10 percent in energy usage could be achieved by means of smart metering alone. This strikes us as a conservative estimate. There is ample evidence that human beings can change their behaviour in response to information—the effect of fuel consumption gauges on driving habits is just one example. Although there is little experience of smart metering at domestic level, our visits both to

Leicester and Gothenburg revealed on a larger scale the impact of access to real-time data upon energy consumption.

5.50. In Leicester the Council have invested in an energy and water monitoring system. This is made up of three elements: meters in Council-run properties, such as schools, collecting information half-hourly; radio antennae that relay the information; and a central software system, that logs and analyses it. The software establishes parameters of normal usage, factoring in variables such as weather conditions, and instantly identifies aberrations, to which Council staff are alerted daily. The system cost some £500,000, and as a result the Council have identified savings of around £160,000 per annum. In parallel the Council have developed an energy labelling scheme for public buildings, as well as information panels displaying real-time information on energy use and carbon emissions.

5.51. The system in Gothenburg is similar, though more ambitious in scale. The municipal housing association, Poseidon, owns some 23,500 apartments, heated for the most part through the district heating system. Poseidon has invested some £8 million in a system that monitors demand, regulates energy supply, and identifies aberrations. As a result energy consumption has fallen from 186 kWh/m^2 in 2000 to 157 kWh/m^2 in 2004—a fall in energy use of some 15 percent. This represents a saving of around £2 million per annum, and a reduction in carbon dioxide emissions of around 1,900 tonnes per annum. Throughout this period average December temperatures in apartments have been between 21.1 and 21.4°C.

5.52. Thus in both Leicester and Gothenburg investment in smart metering and monitoring of energy use has shown the potential to pay for itself within 3-4 years. In Gothenburg it has led to a fall in energy consumption of around 15 percent, without any significant change in internal temperatures. Such results demonstrate the large amount of energy that is at present simply wasted—heating and ventilation systems are operated inefficiently, lights or appliances are left on when not in use, and so on. Readily available, good quality data will be essential if such waste is to be reduced. The message from Leicester was simple and clear: "if you can't measure it, you can't manage it".

5.53. The message has not been lost on business—Mr Farrow, of the CBI, drew attention to a "well-known UK retailer" which has "installed half-hourly monitoring on energy use in [its] stores" (Q 571). However, since 2001 the Government themselves seem to have done little or nothing on smart metering—an assessment that even the Minister accepted as a "fair comment", although he did tell us that Ofgem was now working on a smart metering trial (Q 752). In contrast, Defra's explanatory memorandum to the draft EU Directive on Energy Efficiency, which includes a reference to "actual time use of meters", says, in the words of the House of Commons European Scrutiny Committee, that the Government "does not at present have sufficient evidence of the potential costs and benefits to justify agreeing a commitment to [smart metering]." The Minister similarly emphasised the costs of smart metering, and doubts as to whether it would be "worth it".

5.54. There is no doubt that rolling out remote domestic metering technology countrywide would be extremely expensive, while the millions of units required for commercial, industrial and public sector premises would in many cases be more complex and still more expensive. Understandably, therefore, the supply companies do not appear to have an appetite for the task. As Mr Alistair Phillips-Davies, of Scottish and Southern Energy, told us, the existing regulatory regime "has driven us to the lowest cost denominator and the lowest cost denominator is what you have got"—that is, electricity meters costing around "six or seven pounds". Smart metering technology would be an additional cost which the supply companies seem unwilling to bear: "you have got no incentive or framework in the UK market to motivate anybody to invest in anything of this nature on a long-term basis. So you will not see anything like that for many years to come unless somebody substantially changes the way the metering market works" (Q 377).

5.55. This is a depressing conclusion, and underlines the need for Government leadership. In marked contrast to the inaction in this country, in Canada the government of Ontario recently established targets for the installation of 800,000 smart electricity meters, providing remote meter reading and the option of customer display units, by the end of 2007, and the installation of such meters for all Ontario consumers by the end of 2010.[45] The costs are estimated at $250CAN (around £100) per domestic meter. We see no reason why comparable targets should not be set for the United Kingdom. The investment would be considerable, but no greater than that committed to other carbon-saving programmes, such as the Energy Efficiency Commitment and the Renewables Obligation—or to the programme of installing water meters. At the very least a large-scale trial is urgently required.

5.56. On the other hand, a basic domestic "smart" electricity meter—a simple device monitoring current and relaying the information to a display unit—would be very cheap. It would not, of course, monitor gas consumption, but would still represent a significant step forward in allowing individuals to monitor their own energy use.

5.57. **Since 2001 the Government has dragged its feet on smart and remote metering, and now appears to be resisting draft European legislation that would require more rapid development of the technology. We deplore this. In the long term, the surest way to achieve lasting reductions in energy use is to empower consumers—to provide them with the information that enables them to manage their energy use. We therefore urge the Government to take the lead in establishing a large-scale trial both of remote metering and of low-cost options for "smart" domestic display units, which could be rapidly developed and rolled out.**

[45] See www.oeb.gov.on.ca/html/en/industryrelations/ongoingprojects_smartmeters.htm.

CHAPTER 6: NEW BUILDINGS

Background

6.1. In this chapter we consider new buildings; in the next we consider the existing building stock. This is to some extent an artificial distinction, and in both chapters there are cross-cutting issues. Indeed one major cross-cutting issue, the provision of heat, is dealt with separately in Chapter 8.

6.2. We have also touched occasionally in these chapters on the commercial and public sectors, to which we have not devoted a separate chapter. This is because the bulk of energy use in these sectors derives from the operation of buildings themselves, rather than from any particular processes that are conducted within them, and similar principles apply as to the domestic sector. However, much of the commercial sector, in particular, is also covered by instruments such as Climate Change Agreements, and these are considered in Chapter 10, which focuses on industry.

6.3. Buildings are fundamental to energy policy and to the economy as a whole. According to the Government, buildings contribute almost half—about 46 percent—of the United Kingdom's greenhouse gas emissions, cutting across domestic, commercial, public and industrial sectors (p 13). Construction is responsible for about 5 percent of GDP, rising to 8 percent if the value of construction materials and related components is included.[46] The industry employs, according to the BRE, around 3 million people, spread over some 350,000 individual businesses (Q 501).[47]

6.4. It is estimated by ODPM that in 2003 there were around 25.5 million households in the United Kingdom, and 21.5 million in England.[48] The number in England alone is increasing at a rate of around 160,000 per annum, as a result both of population growth and the diminishing average size of households. The number of houses is also increasing, though at a slightly lower rate. The achieved construction rate for new houses in England since 1996 has averaged around 141,000 per annum (as against a target of around 155,000). ODPM seeks to raise this to 180,000 per annum, still considerably less than the figure of 242,000 recommended in Kate Barker's 2004 *Review of Housing Supply* as necessary in order to bring down house price inflation.

6.5. Thus Government targets, if met, would mean almost a million new houses being built in England by 2010, and another million by 2015. According to the Government, household emissions in 2002 were somewhat over 40 MtC, about 3 percent lower than in 1990, although the share of the United Kingdom total represented by households had in fact risen from 21.6 to 24.3 percent. The Government further state that "carbon dioxide emissions [from households] are expected to decline by about 16 percent between 1990 and 2010",[49] asserting that this projection takes account of the growth in the number of households. However, we are uncertain whether this figure

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46 See Sir John Fairclough's 2002 report, *Rethinking Construction Innovation and Research*, p 9.

47 Estimates, however, vary between about 1.5 and 3 million.

48 See House of Commons Environmental Audit Committee, 1st Report, Session 2004-05, *Housing: Building a Sustainable Future* (HC 135-I), pp 6-7.

49 *Review of the UK Climate Change Programme*, p 61.

includes the carbon released as a direct result of construction of new houses, estimated by the Environmental Audit Committee as around 1.4 MtC per annum.[50]

6.6. Within the housing sector, just over 60 percent of energy is consumed in space heating, and a further 23 percent by hot water; the next most significant consumer of energy is lighting and appliances, which make up just 13 percent of the total. Cooking consumes less than 3 percent. Although no comparable breakdown of energy consumption exists for commercial and public sectors, it is clear that because of the relatively high reliance on electrical appliances (lighting, refrigeration equipment, computers and so on) heating and hot water will represent a smaller, though still high, proportion of the total.

6.7. Of all these categories of domestic energy consumption, only cooking has seen a reduction since 1990; energy consumed in space heating has risen by some 22 percent over the same period, partly because of the continuing rise in average internal temperatures.[51] The decline in emissions since 1990 thus appears to be a product of one-off fuel switching rather than falling consumption. It is therefore difficult to see how the Government's projected decline in carbon emissions will be achieved on the basis of current trends.

Building Regulations

6.8. Minimum standards for energy efficiency in new and refurbished domestic buildings are defined in Part L of Building Regulations.[52] The Government recently completed a consultation on its latest proposals to review Part L, which will come into effect from January 2006. The new standards are expected, according to the Government to mark an improvement in buildings of "around 25 percent in terms of their carbon emissions." (p 3)

6.9. The latest revision of Part L is one of a series of reviews of energy efficiency standards. An earlier revision, in 2002, was itself expected to deliver a 25 percent improvement in energy efficiency. In addition, the Government have announced that from 2010 to 2020 they will "aim to update the Building Regulations every five years or so and at each update will clearly signal what the next stage is likely to be, leading to incremental increases in the energy standards of new and refurbished buildings". As part of the consultation on the current review the Government published a paper outlining measures that "might be appropriate for a further amendment to the Building Regulations around 2010" (p 14).

6.10. The potential scope of Building Regulations was significantly widened by the passage of the Sustainable and Secure Buildings Act 2004, which allowed for the addition of new purposes for which Building Regulations could be made, including environmental protection and sustainable development. The Government indicated that as standards were raised in 2010 and beyond, "it is likely that buildings will need to incorporate an increasing number of cost-effective, low or zero carbon technologies"—including renewable energy sources, micro-CHP, and passive design features.

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50 *Housing: Building a Sustainable Future*, p 48.

51 A breakdown of the data is contained in Dr Sinclair's paper: see Appendix 4.

52 Building Regulations cover England and Wales; in Scotland building standards are covered by a separate, devolved system.

6.11. Opinions differed as to the level at which Building Regulations are set, compared to other European countries, and the impact of the latest review. Professor Oreszczyn said that in the past Part L had "lagged behind" other countries, but felt that the latest proposals would "bring us up to a pretty comparable standard to that in several other European countries. It will not bring us to the top but it will bring us up to a level which is certainly similar to similar countries at the same latitude". Professor Sandy Halliday, of Gaia Research, put a different gloss on the same point: "The simple answer to your question is: no, they are not adequate … the new regulations, with a good following wind, may just about bring us to a standard which is not quite as good as that in many other countries in Europe". She believed there would be enormous benefits and opportunities in "radically improving our Building Regulations" (QQ 141-144). It is notable that in some respects Part L lags behind even pre-existing standards in Scotland: as the Energy Saving Trust have pointed out, the proposed minimum U-value[53] for walls of 0.35 is well above the 0.27 required in Scotland.[54] However, such differences can in part be explained by latitude—the colder the climate, the more cost-effective insulation is.

6.12. Professor Oreszczyn blamed this shortfall in building standards squarely on resistance to change within the construction industry (Q 143)—a point that appeared to find confirmation in the evidence from George Wimpey, who argued that it made more sense "to improve existing housing stock than to load new homes with even more targets, which will achieve minimal gain at significant load costs" (p 294). However, Professor Oreszczyn also felt that the industry's resistance was compounded by the "very short timescales" given during reviews (Q 143). He noted that in the past "there has been quite a lot of watering down of draft proposals", and was concerned that this might be repeated in the current review. Professor David Strong, of the Building Research Establishment (BRE), said that the low standards were "the result of very effective lobbying in the UK from organisations with vested interests that have no desire really to change working practices or the quality of buildings they are constructing" (Q 528).

6.13. However Dr Martin Wyatt, Chief Executive of the BRE, pointed out that there was a risk in simply increasing standards: "It would be very easy to come up with what on the face of it look like sensible performance criteria, but which translate into very, very expensive answers. If you take, for instance, the forthcoming Part L, in terms of insulating a house we are probably moving now to the realms of diminishing returns". In other words, if the objective of energy efficiency is to save carbon, "then you have to look at the most cost-effective way of doing that, not what is the most sexy way". To go much further than the Part L standard for insulation would require a "step-change in technology and a step-change in costs" (QQ 523-525). At the same time, our experience of houses built using modern methods of construction (MMC), both at the BRE itself, and in Sweden, shows that the technology for such a step-change is readily available, if the industry is prepared to take it up.

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53 The "U-value" is a measure of the amount of heat transferred through one square metre of a given material, given a temperature differential of one degree Kelvin. It is expressed in watts per square metre per degree difference (W/m^2K).

54 From the EST response to ODPM's consultation on the Building Regulations, dated 22 October 2004 (http://www.est.org.uk/uploads/documents/Building_Regs_consultation_EST_response.doc).

6.14. **It is disappointing that the standards of energy efficiency required by Part L of Building Regulations will, even after the latest review, not match the best standards in Europe. We have considerable sympathy with those who argue for a step-change in these standards. However it appears on balance that the construction industry in this country is not equipped, particularly in terms of skills, to cope with such a step change. The Government's approach of regular reviews between now and 2020 therefore represents a pragmatic approach. However, it is essential that the Government set a clear direction for the next 15 years, and demonstrate its determination not to let a conservative industry hold back progress.**

The Code for Sustainable Buildings

6.15. A further initiative to raise building standards, announced by the Government in their response to the report of the Sustainable Building Task Group in July 2004, is the development of a "Code for Sustainable Building". This would "set standards for energy, water, waste and other environmental issues, going beyond the minimum standards set out in Building Regulations". The Government launched a preliminary outline of the Code at the Sustainable Communities Summit in early 2005, and aim to complete the Code by the end of 2005. The Code would be non-statutory, but the Task Group recommended that the Government show leadership by adopting the Code for all new buildings, refurbishments, or procurements.

6.16. The Code is an important development, though not an entirely new departure. The BRE, working with the construction industry, introduced the BREEAM[55] standard for commercial buildings in 1990, and the similar EcoHomes standard for domestic buildings in 2000. Both give weighted scores for a range of environmental impacts, including energy, transport, water, materials and waste, producing an overall rating of Pass, Good, Very Good or Excellent. Since 2000 some 10,000 homes have been certified to EcoHomes standards.

6.17. The relationship between the new Code for Sustainable Buildings and the existing BREEAM and EcoHomes standards remains unclear. The Task Group recommended that the new Code be based on the BRE standards, while also recommending the Code incorporate "clearly specified minimum standards in key resource efficiency criteria", including energy use (see p 15). Since then the Environmental Audit Committee has expressed concern that the BRE standards, in failing to set such minimum standards, allow builders to offset poor performance in areas such as energy against "excellent" performance elsewhere. However, Dr Wyatt indicated that BRE accepted the Task Group recommendation that "there should in essence be non-tradable credits with EcoHomes and BREEAM, which would guarantee standards for achieving an "excellent' rating" (Q 521).

6.18. A balance must clearly be struck. Minimum standards in key areas are necessary, but equally the overall environmental impact of a building is not just a matter of hitting individual targets—it is the product of many factors, which in some cases must be balanced against one another. We therefore welcome the BRE's willingness to take on board the Task Group

[55] BREEAM stands for Building Research Establishment Environmental Assessment Method.

recommendation for minimum standards in specified areas, and urge the Government to respond equally constructively.

6.19. It makes no sense to reinvent the wheel, and we welcome the fact that the Government's response to the Task Group report indicated an intention to build on the BRE's work. We note, however, that their evidence to our inquiry makes no mention of collaboration with the BRE, and when we visited the BRE in late 2004 we were concerned to discover that the Government were considering developing a wholly new Code. We were only partially reassured when Dr Wyatt told us in February that the BRE was still "engaged in dialogue" with ODPM, and had made a proposal about "how BREEAM and EcoHomes might be adapted to meet their objectives" (Q 522).

6.20. **We strongly believe that the new Code for Sustainable Buildings should build upon the existing BREEAM and EcoHomes standards. There is no need to reinvent the wheel. BREEAM and EcoHomes are well-established, and have been developed with the full input of the construction industry as well as the research expertise of the BRE. We doubt that any new Code would have similar authority or would command similar support.**

6.21. One of the advantages of the Code will be that it will set voluntary standards higher than those statutorily required by Building Regulations. In light of the regular reviews of Building Regulations promised between now and 2020, and particularly of the concern expressed by Professor Oreszczyn over the "very short timescales" for previous reviews, which have created difficulties for the construction industry, the Code will allow the Government to set out the long term direction in which standards are likely to move. In the words of Mr Steve Irving, Director of Building Research at Faber Maunsell, but also involved in the current ODPM review of Building Regulations,

> If we can have a system whereby the standards that were in a Sustainable Code were the basis of, say, the Part L standards at the next review, then industry has got a target which it knows it is going to be aiming towards. Equally importantly, there will be a body of experience of constructing to those standards, so that good practice can move into mainstream practice in a much more seamless way than happens at the moment (Q 195).

6.22. We note that ODPM, as part of its consultation on the revision of Part L, has published papers setting out aspirational standards for 2010, and on possible adaptations to Part L in response to climate change.[56] **We welcome this initiative, and recommend that aspirational standards in future be built into the Code for Sustainable Buildings, so as to give a clear signal to the industry of future trends in Building Regulations.**

Enforcement

6.23. While Building Standards are reviewed, deep concern remains over the extent to which even the existing standards are in reality achieved. Local authorities check plans for compliance before planning permission is granted, but while plans may be compliant, the mechanism for ensuring that the resulting buildings comply is far less robust. As Professor Oreszczyn noted,

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56 See sections 6 and 9 of the consultation, on "Possible future performance standards for Part L" and "Building Regulations Part L: Adaptation Strategy" respectively.

"the regulations set targets. You can try to design to those targets but then there is a real issue about what actually gets built" (Q 148). Enforcement was traditionally the responsibility of local authority Building Control sections, but more recently builders have been able also to turn to approved inspectors, who are not employed by the local authority, and ODPM is looking to extend the possibility of self-certification.

6.24. While the introduction of an element of competition may have had the effect of reducing bureaucracy and costs, it is clear that it has also driven down the quality of enforcement. In the words of Professor David Strong of the BRE, there is now "a competitive market with building control officers competing one with another on commercial grounds, and no building control officer wants to be seen as a stickler" (Q 534). Professor Strong gave the following examples of non-compliance:

- Designs which met Government standards by including condensing boilers, but where developers cut costs by installing conventional boilers;
- A study by De Montfort University revealed that 98 percent of builders were failing to display energy performance certificates, required by the 2002 revision of Building Regulations;
- Hot water cylinders in the Flagship Home in Westminster (a project supported by the Energy Saving Trust) had only the most rudimentary, non-compliant insulating jackets;
- A survey conducted by BRE revealed that two thirds of domestic buildings failed to reach the 2005 indicative standard for air permeability—which itself is three times less stringent than that applied in Germany.[57]

These examples together form a damning indictment of building standards and compliance with regulations within the building industry.

6.25. It is notable that Sweden has achieved exceptionally high building standards, not only through prescribing high design standards, but, in the words of Ms Lynne Sullivan, an architect, by being "very rigorous about their validation and the monitoring of that standard" (Q 150). However, it was suggested during our visit to Sweden in January suggested that since this stringent and highly bureaucratic system was relaxed in 1995, with fewer inspections and the placing of greater responsibility upon construction companies themselves to guarantee technical quality, standards in Sweden too have fallen significantly.[58] Professor Strong warned against the extension of self-certification here: "It can be made to work, but only if it is done within a proper competent person framework, by proper quality assurance checks, with random checking" (Q 535). It appears that no such stringent process of quality assurance is in place at present.

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57 The indicative, non-mandatory standard proposed in the 2005 revision of Part L is 7.0; the standard in Germany is between 1.8 and 3.6, depending on the type of building; the standard in Switzerland is 3.6. The Government's consultation paper suggests that "it may be appropriate" to reduce the Part L standard to 5.0 in 2010. The same paper notes that improvement in air-tightness to something approaching German standards would reduce the emissions from heating an average semi-detached home by about 30 percent (section 6, paragraphs 38-39).

58 See also "Energy efficiency—a forgotten goal in the Swedish building sector?", by Jonas Nässén and John Holmberg, *Energy Policy* 33 (2005), pp 1037-1051, in particular pp 1047-1048.

6.26. The competitive market in building inspection is not the only problem: the way Building Regulations are drafted makes enforcement hugely problematic even for local authority Building Control sections. As Mr Simon Barnes, of ODPM, told us, Building Regulations are "functional"—that is to say, they do not prescribe, for instance, double glazing, but a certain level of energy efficiency, which in practice is likely to be achievable only if double or triple glazing is used (Q 727).

6.27. This sounds reasonable in the abstract, but it adds to the complexity of enforcement. As Professor Strong pointed out, in practice the building industry has "managed to persuade Government to allow design flexibility as part of the Building Regulations compliance process so that it is possible to demonstrate compliance in a number of different ways". Professor Strong's conclusion was that within the competitive market for building inspection, the only way to achieve higher standards was "the introduction of some simple but mandatory pass/fail tests, one of which would be air-pressure testing for all buildings". We note Mr Barnes's comment, that the Government are looking to make pressure testing obligatory in the new Part L regulations. We also note that infrared cameras are available to test the continuity of cavity insulation, although they are still expensive and therefore not widely used (QQ 528, 534, 732, 153).

6.28. There is also a question as to what happens to buildings that are discovered to be non-compliant. Prosecution is the responsibility of the local authority, although, as the Environmental Audit Committee recently pointed out, prosecutions are time-limited to six months after the discovery of the fault, and in practice the resources of Building Control sections are already stretched by the need to conduct routine inspections.[59] But even if non-compliance is proved and a prosecution brought, there is a practical limit to quality control—whereas in the case of most goods purchasers have a right to exchange faulty items, there is no such possibility for houses. As Professor Halliday commented, "if it does not comply, do you take it down? That is unlikely. I am not aware that it has ever happened." In short, there is no final sanction for buildings that fail to comply (Q 149).

6.29. **We share the alarm of the Environmental Audit Committee at the "apparent ease and possible extent of non-compliance with Part L of Building Regulations", and endorse their recommendation that ODPM conduct a thorough review of the problem.**

6.30. **We are concerned that the introduction of competition and self-certification into the building control process has already led to falling standards, and will continue to undermine efforts to raise standards. We urge the Government to ensure that adequate quality assurance, through a system of formal accreditation, is in place to underpin the process.**

6.31. **We further recommend that the Government increase the resources available to local authority Building Control sections in order to assist them both in on-site inspection and in bringing prosecutions for non-compliance.**

6.32. **With increased design flexibility, and in the absence of clear, mandatory pass/fail tests, or specific requirements for components**

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59 *Housing: Building a Sustainable Future*, pp 43-44.

such as double glazing, the task of monitoring and enforcing compliance with Building Regulations has become almost impossible. We recommend that the Government introduce a series of mandatory tests for completed buildings. In particular, we look to ODPM to abide by its stated intention to introduce mandatory pressure-testing for all new buildings.

Construction: skills and training

6.33. Bound up with the question of enforcement is that of skills in the construction industry. Witnesses were generally scathing: Ms Sullivan, a practising architect, described the skills base as "lamentably poor", and noted the reliance of the industry on European labour—"presumably because they are the only people who have the skills" (Q 150). Professor Halliday said that we were "70,000 plumbers short of the requirement in the UK. We do not have anything like the number of carpenters we need … the skills are not there" (Q 174). Dr Wyatt noted that the skills shortage was "witnessed simply by the amount of faults which are found—snags at the end of the project when the builder has to come back and put this right and that right, and he hopes you will not notice he has bodged that and so on—which is endemic" (Q 537). The Adult Learning Inspectorate, in a recent report, estimated that the industry was "currently 300,000 workers short of capacity", and needed to recruit and train "some 88,000 new entrants each year for the next five years".[60]

6.34. This skills shortage is a matter of particular concern in a time of rising energy efficiency standards, which in turn demand greater understanding and attention to detail on the part of builders. The point was forcibly made by Mr Irving:

> "I think that as we improve the insulation standards of houses the relative importance of what are apparently small defects in the construction becomes much greater, things like thermal bridges and air tightness … I think the workforce does not realise how significant these apparently small defects are … it is a bit like someone saying, 'My bath is perfectly watertight except you have forgotten to provide me with a plug' … That is really what we are doing at the moment, providing a wonderful bath where the walls have got lots of insulation but it is all leaking out through these apparent defects." (Q 212)

6.35. The Government are clearly aware of the skills shortage. In 2003 Sir John Egan was invited to conduct a review of the issues, and his report, *Skills for Sustainable Communities*, was published in April 2004. Nevertheless, the Action Plan contains few concrete proposals. It concedes that "raising industry skills will be vital", but mentions only one programme which might contribute to this goal, in which the Energy Saving Trust, in partnership with Skills Councils and others, have launched an "Energy Efficiency Installer Certificate", intended to provide 70,000 installers with the skills necessary in install condensing boilers.[61] It then states that "Defra is also working with EST to investigate how to support skills in other key industry sectors such as insulation". Mr Eppel, of Defra, also drew attention to the EST initiative on installers in oral evidence (Q 35).

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60 *Building the future: skills training in construction and building services engineering*, Executive Summary (see http://docs.ali.gov.uk/surveys/construction_may05/report/1/sub1/1.htm).

61 Action Plan, p 76.

6.36. At the same time, the programme of apprenticeships in the construction sector, which is administered by the construction industry Sector Skills Council, CITB-ConstructionSkills, has been much expanded. Mr Ian Hornby, of the House Builders Federation (HBF), the one witness to dissent from the generally scathing view of skills in the industry, noted that there had been "over 60,000 applications for apprenticeships in the construction industry, far more than the industry can actually cope with". This figure may be compared with the 88,000 entrants needed each year by the sector (paragraph 6.33). Mr Hornby confirmed that the HBF would continue to work with CITB-ConstructionSkills to "enable new people to enter the industry with the appropriate skills" (Q 213). However, concerns remain over the drop-out rate for apprenticeships—the Adult Learning Inspectorate report notes that for the full construction apprenticeship and advanced apprenticeship achievement rates are 24 and 38 percent respectively. In the words of Dr Wyatt, "well over £140 million a year [is spent] in helping apprentices and putting training in place, but a lot of people join the industry and then leave the industry, it evaporates out at the far end" (Q 537). Mr Irving identified a continuing lack of resources in ODPM for training up to the new standards as a gap that "still needs to be filled" (Q 191).

6.37. The issue may ultimately be cultural. Dr Wyatt continued by noting that the reasons for poor workmanship are partly to do with management and partly to do with skills, but also to do with pride: "if you have pride in your skills and your job, you are less likely to do these things. If we do not respect people's standing as skilled artisans in society, then we cannot be surprised when we do not in return get a high level of skills" (Q 537). High standards in Building Regulations, thorough inspection and enforcement, and skilled workmanship, are mutually supportive. As Professor Halliday argued, the industry as a whole needed "training on process and when things have to happen". She expressed the hope that the Code for Sustainable Buildings might embody this holistic approach, incorporating "ideas as to when things needed to be done and what would happen if they were not done" (Q 149).

6.38. Unfortunately the structure of the industry militates against such a change. It is heavily dependent on on-site skills, rather than higher quality factory-made components—an issue we discuss in more detail below. Moreover, the price of new houses today is dominated by the price of land—the value added by good build quality is so slight as to create a positive incentive to cut corners. At the same time, speculative builders, who sell properties on as soon as they are complete, have no interest in the long-term costs of energy or other resources. Nor do most builders appear to have much faith in their customers' willingness to invest in energy efficiency: Mr Hornby suggested that "the anecdotal evidence does not suggest that people are willing to pay extra for increased insulation" (Q 201)—a point confirmed in written evidence from George Wimpey (p 294). However, this was contradicted by Ms Janet Young, of the Peabody Trust, who cited research demonstrating that people buying real properties in the London Borough of Sutton, had been "prepared to pay a premium of between 8.5 percent and 18 percent" for energy efficient buildings (Q 200).

6.39. **Skills shortages pose a serious threat to the Government's energy efficiency targets, particularly given the major house-building programme now under way. It is essential that the Government address these issues in a more energetic and co-ordinated fashion than they have done hitherto.**

6.40. **Skills shortages are compounded by a widespread culture of sloppy workmanship and cost-cutting by builders. This must change, and in tandem with improved enforcement of building standards we recommend that the Government strengthen the legal rights of purchasers who acquire poorly built properties.**

Energy Performance of Buildings Directive

6.41. The Energy Performance of Buildings Directive will be implemented in January 2006. Of particular relevance is the Directive's requirement that all properties should be provided with Energy Performance Certificates when they are constructed, sold or rented out. In addition, such certificates will have to be publicly displayed in "public buildings" of over 1,000m^2. We have already drawn attention to the claim by Green Alliance that such performance certificates, when incorporated into the Home Information Packs that will be required from 2007, and backed up by fiscal incentives to improve energy efficiency, could exert a powerful influence upon householders.

6.42. We would go further. At present, as George Wimpey observed with a degree of understatement, the general public has "a comparatively low level of awareness" of buildings' Standard Assessment Protocol (SAP) rating (p 294). The requirement for public buildings to display energy performance certificates raises the possibility that, like "Investors in People" accreditation, the certificates could become a desirable demonstration of good practice in resource management. This influence could potentially extend far beyond the public sector, including to sectors, such as SMEs, which have hitherto been largely overlooked.

6.43. For this to happen the Government will have to provide momentum by applying the Directive broadly. Unfortunately, there is little sign of this happening. The Government have yet to decide whether the term "public buildings" encompasses only buildings that are publicly owned, or in addition all buildings that are accessible to the public—which would include, for example, cinemas. Mr Barnes, of ODPM, said that "We are yet to discover what 'public buildings' means"—which is alarming, given that the Directive was agreed as far back as 2003, and is due to be implemented in less than six months. In contrast, we were told at the Swedish Ministry for Sustainable Development that the Swedish Government was likely to interpret the term so as to encompass all buildings where the public gathered, even if privately owned (Q 746).

6.44. Mr Barnes also noted that the initial definition of "public buildings" would have a bearing on the number of inspectors needed to enforce the Directive. Again, there seemed to be little sign of advance planning: "Maybe in a few years' time it will be extended and we will need a few more inspectors but we need to be sensible about how we apply this to make sure that it can be done with the number of people we have available" (Q 746). This was borne out by Professor Strong's damning assessment of the United Kingdom's state of preparedness: "The UK can apply for an extension of up to three years in the event that there are insufficient number of qualified and trained assessors to undertake building certification and plant inspection requirements. That is rapidly becoming a self-fulfilling prophesy simply because no training has started … there is no method yet agreed for assessing non-domestic buildings to be compliant, and no training has started" (Q 532). Again in marked contrast, the Swedish Government already has plans for a training programme in the introductory phase 2006-08.

6.45. **The Government appear to have done little to prepare for implementation of the Energy Performance of Buildings Directive. We fear, for instance, that the Government's failure to train adequate numbers of inspectors will be used as an excuse for deferring full implementation, or for adopting a narrow, "lowest common denominator" interpretation of the term "public buildings". We deplore this prospect, and urge the Government both to adopt a broad definition of "public buildings", and to make preparation for the Directive a high priority between now and January 2006.**

6.46. **Energy Performance Certificates could potentially be as influential in improving building standards and advancing the Government's energy efficiency objectives as "Investors in People" accreditation has been in promoting good management practices. We therefore urge the Government to give careful thought to the design and display of certificates.**

The scope for improving building standards

6.47. As we have already indicated, over 80 percent of the energy consumed in domestic buildings is used for space heating and hot water. This is therefore the area in which major gains in energy efficiency can be made. Above all, there is enormous potential to use passive design—that is, design which uses inherent qualities of structure and materials to minimise the need for mechanical heating or cooling.

6.48. Although there are examples of passive design in this country, as well as of low or zero carbon technologies, the only passive development we visited in the course of our inquiry was at Lindås, near Gothenburg. The architect, Mr Hans Eek, has been designing energy efficient housing since the 1970s, though he admitted that many of his early projects had been over-complicated, with an excessive reliance on mechanical devices. At Lindås, in contrast, his analysis of the issues was fundamentally simple: the key, he argued, was to make the house air-tight, and then to control the flow of air into, out of, and around it. By applying this principle, he has produced houses which, despite the Swedish climate,[62] require no heating. A more detailed description of Mr Eek's approach is given in Box 2.

6.49. The challenges of passive design vary according to location and climate. In Sweden the main focus is to bring heat into the building; in marked contrast, Mr Eek recalled a passive house in Arizona, where the challenge was to prevent over-heating. Indeed, the architecture of many hot countries bears testimony to the way in which builders throughout history have incorporated elements of passive design.

6.50. The challenge in the United Kingdom falls somewhere between these two extremes. Heat is lost from buildings, as Mr Eek pointed out, through transmission (e.g. through walls), through ventilation, and through water (e.g. sewage). We have already drawn attention to Dr Wyatt's view, borne out by Mr Irving (Q 201), that cavity wall insulation requirements in Part L

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62 Gothenburg, which lies on a similar latitude to Aberdeen, has a maritime climate not dissimilar to much of the United Kingdom.

are approaching the point of diminishing returns, given the British climate—in other words, there comes a point when, given the difference between internal and external temperatures, energy losses through walls cease to be significant. The key in most parts of the United Kingdom is therefore to reduce ventilation losses—not to add ever thicker insulation, but to improve the air-tightness of the finished building. As Ms Sullivan pointed out, in a typical new building "you can expect … one or two air changes per hour"; in a high performance building, you would aim for a figure "around one-tenth of that or less". The impact upon the final heating requirement is huge. But in order to achieve these results, one relies as much upon build quality as good design—"you are basically predicting by proper design and proper quality control what that variable leakage factor is" (Q 154).

BOX 2

Lindås

A continuous layer of insulation, with no thermal bridges, runs through the walls, roof, and under the floor, varying in thickness between 30 and 50 centimetres; the windows are triple-glazed, with krypton gas filling and a U value of 0.85 (compared to a worst acceptable value, under the revised Part L, of 3.3). Overall, the houses are four times as air-tight as the standard required by Swedish building regulations. An internal ventilation system ensures that air is circulated around the house—all incoming air is warmed to near the ambient temperature by means of a heat exchanger, which recovers around 85 percent of exit heat. The houses are also laid out in such a way as to maximise solar heat: large south-facing windows collect warmth in the winter, when the sun is low, but balconies and overhanging roofs mean that the windows are shaded in summer. North-facing windows, in contrast, are small. The remainder of the heat is supplied by the occupants themselves and their electrical appliances, whose total output is calculated at around 0.5 kW on average. There is no separate heating system.

6.51. If such improvements in design and build quality are to be achieved, we believe that the construction industry will have to embrace Modern Methods of Construction (MMC). These remain controversial—the debacle of timber-framed houses in the 1980s, when poor build quality contributed to serious problems with mould and rot, and the inherent conservatism of the industry, mean that MMC has yet to gain much of a foothold. Nevertheless, the incorporation of prefabricated units, for instance wall units which incorporate insulation and wiring, makes quality control much easier. As Dr Wyatt said, "if everything is made to factory tolerances rather than built on site, it is much more likely it will pass air-tightness tests than something which is fabricated from bricks, mortar and bits of timber on site" (Q 537). We also note that MMC is familiar not just in northern Europe, but in North America, and that there is no reason in principle why techniques which have worked well and proved cost-effective in those countries should not work equally well here.

6.52. Indeed, the cost of the Lindås development was, according to Mr Eek, closely comparable to the cost of a normal development built to Swedish standards—the additional costs of insulation and the heat exchanger were offset by the saving in not installing central heating. We have also been informed of a private project to build a wholly passive house in the Isle of Wight, using components imported from Canada, which, as a single development cost some £880-930/m^2 (excluding the cost of piling the foundations). This compares with a target cost for the ODPM's competition to build large numbers of new houses for £60,000 or less of around £785/m^2. Such figures suggest that MMC, once it becomes more widely used, could certainly be cost-effective in the United Kingdom.

6.53. One other benefit of MMC would be the increasing use of wood rather than bricks and mortar. Wood, particularly if it is locally sourced, offers a double benefit: trees draw carbon from the atmosphere, which is then locked up in the building, whose embodied energy thus contributes to a net reduction in atmospheric carbon. In contrast, the production of bricks, mortar and cement is highly carbon-intensive.

6.54. Nevertheless, there are also circumstances, particularly in warmer parts of the country, or in larger buildings such as offices, where cooling rather than heating is often the priority, where the use of high thermal mass—for instance, large volumes of exposed concrete—will offer greater "passive" benefits. The effect of high thermal mass is to even out variations in temperature, absorbing excess heat and releasing it at night, so removing or at least mitigating the need for air conditioning. While the production of concrete is itself energy intensive, the gains over the life-cycle of a building are considerable—as the British Cement Association commented, "the energy consumption of a well-designed, high thermal mass building is typically about half that associated with a modern, good practice air conditioned office" (p 202). This point was confirmed in our discussion with Professor Karl Gertis at the Fraunhofer Institute for Building Physics near Munich.

6.55. **The scope for improving the energy efficiency of new buildings in the United Kingdom is clear. However, although there have been individually impressive projects such as the BedZED development in Sutton, many more such projects will be needed before it is clear what approach yields the best results. Indeed, the best approach may differ between the north and south of the country.**

6.56. **Modern Methods of Construction have proved to be a cost-effective way to achieve high levels of build quality and energy efficiency in many parts of the world, particularly in colder climates, and we support the Government's aim to introduce them more widely in this country. However, in certain circumstances, particularly in larger commercial or office buildings, or possibly in warmer parts of the country, the cooling effects of high thermal mass may yield better results in terms of overall energy use. We urge the Government, particularly in its role as a major procurer of new building, to show leadership in promoting innovation on the part of a largely conservative industry.**

CHAPTER 7: EXISTING BUILDINGS

7.1. We began the last chapter by noting that there were over 25 million households in the United Kingdom in 2003. Therefore the current building stock will constitute the vast majority of the overall total for some decades to come. Demolition rates for existing properties stand at around 15,000 per annum,[63] less than 0.1 percent of the total stock. This means that unless the demolition rate rises, of the 25 million or so properties standing today more than 24 million will still be standing in 2050.

7.2. Thus improving the energy efficiency of existing properties is hugely important to the Government's long term objectives. The theoretical potential savings in terms of carbon emissions are enormous: one estimate is that if the entire United Kingdom housing stock were to be fitted up to the current standards applied in Sweden, as much as three quarters of domestic carbon emissions would be eliminated.[64] However, many older properties could not in practice be improved to this standard, and the Government's relatively conservative estimate of the technical potential saving is 40-42 percent.[65]

7.3. A breakdown of these savings in terms both of delivered energy and carbon, based on research undertaken by the BRE, is provided in a briefing paper by the Market Transformation Programme, "Ranking of energy saving measure in the home".[66] As we have already noted, over 80 percent of domestic energy is used in space and water heating, and this sector offers the greatest potential gains. Around 4.5 MtC/year could be achieved by installing wall insulation, about half of which would be cavity insulation, half solid wall insulation. Energy efficient, condensing boilers could deliver 2.5 MtC/year, double glazing around 1.0 MtC/year, loft insulation slightly less.

7.4. The figures for cost-effectiveness, however, tell a different story. Hot water cylinder insulation, though delivering relatively small overall savings, is the cheapest way to reduce emissions, at just under £100/tC. Loft insulation and cavity wall insulation cost around £100-150/tC, while condensing boilers cost over £200/tC. Solid wall insulation costs almost £400/tC, double glazing almost £500/tC.[67] Overall, the Government estimate the economic potential saving as around 17-21 percent for 2010, and 28-32 percent for 2020.

7.5. Government policy thus needs to strike a balance between the scale of potential carbon savings and the economic cost. As Dr Wyatt put it, you are looking for "most bangs for buck" (Q 525). Furthermore, different kinds of investment need different approaches. Gas boilers, for example, have to be replaced roughly every 15 years on average; therefore new regulatory

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63 See Action Plan, Annex 6.

64 See P F Smith and A C Pitts, "Buildings and the environment: a study for the National Audit Office", University of Sheffield, 1993. See also RCEP, 22nd report, *Energy—the Changing Climate*, 2000 (Cm 4749), paragraph 6.95.

65 *Improving domestic energy efficiency—a technical overview*, paragraph 7.

66 Market Transformation Programme briefing paper BNDH06—see http://www.mtprog.com/.

67 These figures represent the initial capital investment required, and do not take account of ongoing savings. However, according to Mr Eyre, of the Energy Saving Trust, the net cost to the economy as a whole of EEC is actually negative—in other words, the economy benefits by £100-200 for each tonne of carbon saved (see QQ 297-298). However, the methodology underlying this calculation is not clear.

requirements for high efficiency, condensing boilers[68], will over time affect practically every gas centrally heated household. The replacement cycle for windows, on the other hand, is much longer, while wall or loft insulation may be regarded as one-off investments (though they too have a finite life).

7.6. There is also a very large non-domestic building stock, which potentially could yield considerable energy efficiency gains. However, here statistics are harder to come by—as Professor Oreszczyn noted, knowledge of the non-domestic building stock is "probably 20 years behind" that of the domestic stock. Researchers are confined to making "reasonably good guesses", while seeking funding from the Carbon Trust and Research Councils for further work. Our conclusions on non-domestic buildings are therefore largely reached by analogy with the domestic sector—although we did gather useful information on our visits to Leicester and Durham University, as well as taking evidence from those responsible for administering the Lords part of the Parliamentary Estate.

The Energy Efficiency Commitment

7.7. The Government's principal tool for improving the efficiency of existing homes is the Energy Efficiency Commitment (EEC), the first phase of which (EEC 1) ran from 2002-2005; two further phases will run until 2011. The EEC requires energy suppliers, as a condition of their licence, to achieve targets, set in proportion to the number of their customers, for installing energy efficiency measures in households. The targets do not prescribe how they should be achieved, although various approved measures are permitted, such as improving insulation, installing efficient lighting, appliances or boilers. For each such measure that is installed the supplier receives an energy credit, calculated according to a methodology determined by the Energy Saving Trust. These credits are ultimately submitted to Ofgem and set against the supplier's target.

7.8. EEC is not just a tool for reducing energy use and carbon emissions—it also has a vital role in helping to achieve the Government's target for eliminating fuel poverty by 2010. Customers in the "priority group", for whom energy efficiency measures are heavily subsidised, make up approximately half of the total who will benefit from wall insulation.[69]

7.9. EEC 1, which ran until 2005, set an overall target for suppliers of 0.4 MtC/year, and this has been comfortably met. The target for EEC 2, the first phase of which will run from 2005-2008, is set at 0.7 MtC/year, almost double EEC 1; the Government will consult on the level of the 2008-2011 phase in 2007.[70]

7.10. Not surprisingly, in meeting their targets the energy suppliers tend to focus on the lower cost solutions—notably loft and cavity wall insulation. According to the Energy Retail Association (ERA), a trade association for energy suppliers, 82 percent of the EEC 2 target is expected to come from

68 From April 2005 all new boilers have to be at least B-rated, or at least 86 percent efficient, which means in practice only condensing boilers will meet the new standard.

69 See written evidence from Ofgem, p 308. The EEC interacts with other Government programmes in addressing fuel poverty, notably the Warm Front scheme, which provides grants to households receiving a range of benefits; and the Decent Homes programme, which sets minimum efficiency standards for social housing.

70 Action Plan, Annex 6.

insulation products (p 279). Insulation may look like a "low hanging fruit"—there are an estimated 11 million homes in the United Kingdom with unfilled cavity walls. However, the scale of the challenge presented by the EEC 2 target is clear, and various major issues were raised by witnesses: the reliance on the insulation industry to deliver the targets; the lack of demand for insulation, particularly from owner occupiers; the difficulty, given the temptation to take the benefit of insulation in improved comfort, of translating EEC targets into actual carbon savings; and the high cost of improving older properties without cavity walls.

Capacity in the insulation industry

7.11. The Action Plan anticipates that the current rate at which cavity wall insulation is being installed—280,000 a year—will need to rise by a factor of three by 2009. ERA noted that an average of 600,000 installations a year in 2005-08 will be required of an industry that has historically never exceeded 300,000 installations in any one year, and warned of a potential shortfall of 400,000 compared with the EEC 2 targets (p 280).

7.12. This difficulty is compounded by the fact that the EEC obligation falls upon the energy suppliers, not the insulation companies—in the words of the Institution of Electrical Engineers, the energy suppliers are being obliged "to contribute to building standards over which they have little or no direct control" (p 300). Equally, if there is a shortfall, the penalty will fall upon the energy suppliers, not upon the insulation industry directly.

7.13. In contrast, the evidence received from the Cavity Insulation Guarantee Agency/National Insulation Association did not express any concern over these issues, and from informal discussions with CIGA/NIA we gather that the industry has considerably increased its capacity in recent years, and remains in close dialogue with the Government over the feasibility of achieving the EEC 2 targets. In addition, the fact that EEC 2 is set to run until 2011 provides a long-term signal for the industry, and we therefore expect capacity to expand to meet demand.

Market failures

7.14. It has been extremely difficult to stimulate consumer demand, particularly among owner-occupiers, who for the most part do not fall within the "priority group", and yet constitute some 70 percent of all households. Even at full price, loft or cavity wall insulation can, according to CIGA/NIA, pay for itself in reduced energy bills within 2-5 years, while with the subsidies offered by energy suppliers, payback times for individual consumers can be as short as one year.

7.15. The lack of demand thus appears to be a clear market failure. However, reasons are not hard to find. Insulation, unlike a new boiler or refrigerator, is not a "distress purchase"—customers are not compelled to purchase it by the breakdown of an existing appliance. Thus with energy prices low, it is difficult to inspire householders to invest capital in insulation, particularly as properties change hands, on average, every seven years. Along with this apathy there is the "hassle factor" of clearing loft space, and so on. To overcome these difficulties CIGA/NIA argued strongly for new fiscal incentives to householders—an issue we have already addressed in Chapter 5.

7.16. A specific challenge is the lack of incentive for landlords, who, while normally responsible for property maintenance, do not benefit from ongoing energy savings. Most landlords are in fact local authorities and housing associations, who are, as the EST noted in supplementary written evidence, regulated by the Decent Homes standard, which requires a modest improvement in energy efficiency by 2010. However, there is a greater problem with the private sector, and although the 2004 Budget introduced an energy saving tax allowance, allowing landlords to set insulation costs against income tax, the EST did not believe that "limited tax incentives" would be sufficient.[71] ACE agreed, noting both that the private rented sector contained "a very high proportion of energy-inefficient properties", and that there was still "almost no incentive for either landlord or tenant to improve energy efficiency." Janet Young, of the Peabody Trust, which owns 19,000 properties in London, confirmed that "there is not enough funding to achieve good levels of energy efficiency in our existing houses" (Q 212).

7.17. There are of course individual landlords who set an outstanding example. The Peabody Trust itself has not only completed the BedZED development in Sutton, but is pursuing an active programme of research into energy efficiency and renewable energy, with a view to refurbishing its older properties. In Knightsbridge we visited the "Flagship Home", a project to refurbish a privately owned nineteenth century terraced house, which will provide 19 bedsits and apartments, and incorporates features such as internal wall lining to provide insulation, low-energy lighting and a solar collector to provide hot water.

7.18. However, it is notable that both the Peabody Trust and the owner of the Flagship Home, while their commitment to energy efficiency is laudable, have benefited from capital grants—in the case of the Peabody Trust, from DTI and the European Commission; in the case of the Flagship Home, from the local authority and EST. The fundamental problem remains: energy efficiency carries a significant capital cost, and without enhanced support for landlords wishing to make such investment, it is hard to see progress being made more widely. ACE, in a response to a Government consultation on financial incentives, have already recommended options such as increases in Enhanced Capital Allowances.

7.19. **We urge the Government to consider further fiscal incentives to encourage private and social sector landlords to invest in energy efficiency. We welcome the announcement in the 2004 Budget that the Government would give consideration to a "green landlords" scheme, and look forward to further progress on this proposal.**

The "comfort factor"

7.20. Although improved insulation can mean lower energy bills, a significant proportion of the saving is likely to be absorbed by means of improved living conditions—so-called "comfort taking". The EST's calculation of energy credits under EEC 1 allowed for a "comfort factor" of 45 percent for the priority group and 15 percent for the non-priority group. However, as EST informed us, "various studies … have been unable to identify any statistical difference between the two household types in terms of increased

71 Supplementary written evidence (not printed).

temperatures after building fabric improvements". As a result, Defra has now "assumed an average comfort factor of 30 percent".[72]

7.21. We find this methodology disturbingly lax. We note that EST is still conducting various projects aimed at monitoring the impact of improvements in energy efficiency upon actual energy use, and that it considers such continued monitoring as "vital in order to confirm the level of carbon savings that can be achieved through energy efficiency". We note also Professor Oreszczyn's view that the research community still has "very little hard knowledge of how people actually use energy in buildings", and his plea that the energy suppliers "be obliged to collect good quality data and to make it available to the research community" (p 72).

7.22. **We are concerned that the methodology for calculating the carbon benefits of the Energy Efficiency Commitment is so lax, and so poorly supported by hard data. While we support the data monitoring being undertaken by the Energy Saving Trust, we also recommend that the Government take steps to oblige energy supply companies to collect specific but anonymised data on energy use and make them available to the research community.**

Older houses

7.23. We have already noted that the emphasis under EEC is on lower-cost improvements, such as loft or cavity wall insulation. However, this means that many properties, in which improvements in energy efficiency are less straightforward, risk being overlooked. In particular, there are an estimated seven million properties, mostly built before 1930, with solid walls. The Action Plan notes that internal lining of the outside walls of a typical semi-detached house costs around £900, and brings with it disruption to internal decoration and a reduction in room size. External cladding, requiring scaffolding, is still more expensive, though the marginal cost is significantly reduced when it is added as part of an overall refurbishment, for instance of an apartment block.

7.24. The Government is clearly aware of the difficulties presented by older buildings, and the Action Plan identifies more economic and practical insulation for solid-wall housing as a "key priority for future research and development". We agree. **There is a risk that solid-walled houses, the least energy efficient, will not benefit from the Energy Efficiency Commitment. The development of cheaper and less intrusive insulation for such properties is a key priority for future research.**

Heritage

7.25. The technical challenge presented by older buildings is in many cases compounded by planning and heritage constraints: there are some 300,000 individually listed residential buildings, and a further 1.2 million which are located in conservation areas—representing in total about a quarter of pre-1919 dwellings. The Flagship Home in Knightsbridge, located in a conservation area, demonstrates the impact of such constraints: external cladding was of course not permitted, and internal lining has been used instead; in addition, English Heritage refused permission to replace the front

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72 Supplementary written evidence (not printed).

windows with double glazed units, with the result that while rear-facing windows are new double glazed sashes, at the front the original Victorian sashes remain, with secondary glazing added inside.

7.26. The constraints faced by Durham University in refurbishing both Durham Castle itself, which is a World Heritage Site, and student accommodation within the Durham Peninsular, have been even more severe. For instance, secondary glazing has not been permitted in residences, as it would alter the external appearance, while objections have been raised to the installation of roof insulation in the castle itself.

7.27. While the architectural heritage must be respected, the attitude of local planning authorities and English Heritage to refurbishment of older properties often appears to be unhelpful. Buildings change over time—the architectural heritage cannot be simply frozen. **We recommend that the Government review the guidance issued to planning authorities with a view to developing a more flexible approach to energy efficient refurbishment of older buildings.**

Demolition and refurbishment

7.28. There is also the issue of demolition. We have already noted that the demolition rate in the United Kingdom currently stands at 15,000 per annum. This rate would imply an average life expectancy for houses of over 1,500 years, and is clearly not sustainable. At some point demolition rates will inevitably rise. The Environmental Change Institute, in its report "Achieving the 40% House scenario", notes that the three quarters of pre-1919 homes not listed or in conservation areas "could be demolished if deemed unhealthy and incapable of providing affordable warmth". The Institute recommends that demolition rates should rise to around 80,000 per annum (0.25 percent of the housing stock), focusing on inefficient or unhealthy properties.[73]

7.29. The arguments for and against demolition are complex and controversial, particularly where older buildings are concerned. Such housing, even if it is not listed or in conservation areas, is an important part of our architectural and cultural heritage. On the other hand there are many nineteenth century terraces, often in poor condition, with solid walls, poor air-tightness, and problems with damp or eroding brickwork, which would be expensive to refurbish to anything approaching the standard of new build. With these considerations in mind, **we recommend that the Government review its strategy on demolition of poor quality housing.**

7.30. There is likely to be less controversy over possible demolition of poor quality modern (frequently social) housing. However, at Angered, a 1960s social housing development outside Gothenburg, we witnessed an example of what can be achieved by refurbishment of even the least promising housing. Demolition would have been an easy option, but instead an impressive refurbishment has contributed to both energy efficiency and social renewal. Open ground-floor passages have been converted to safe laundries and communal greenhouses. Insulation has been added on walls and roofs, with solar collectors providing 30 percent of hot water and heating. South-facing balconies have been glazed, allowing passive solar gain. Windows have been

[73] *Achieving the 40% House scenario*, pp 87, 88.

replaced or reglazed. Overall, energy consumption has fallen from 260 kWh/m^2 per annum to 160 kWh/m^2, occupation rates for apartments are better, and communal areas are clearly well cared for. The cost of the project, met largely by the European Commission, was around £400 per m^2—less than half the cost of a new building.

7.31. However, while Angered demonstrates what can be achieved by means of refurbishment even in unpromising circumstances, the tax system in this country does not favour refurbishment. For instance, VAT is currently charged at the full rate on refurbishment, while new buildings are zero-rated—creating a perverse incentive to demolish rather than refurbish. A striking example was reported in March 2005, as we approached the end of our inquiry: in the course of converting Malory School, in the London Borough of Lewisham, into a new sports academy, it was decided to demolish a sports hall, built in 1996-97 with a lottery grant of £725,500. This was because retention of the sports hall would have meant the whole project being treated for tax purposes as a refurbishment rather than new build, so incurring a VAT liability estimated at £4 million.[74] Such profligacy with resources makes a nonsense of sustainability.

7.32. Various bodies have urged a relaxation of VAT rules in order to promote energy efficient goods. However, the Government's application of VAT is determined by the EU, in particular the sixth VAT Directive, which can only be amended by the unanimous agreement of the Member States. The Sustainable Buildings Task Group urged the Government to "to negotiate in the EU to establish amendments to the VAT Directive that allows lower VAT rates to be applicable to a wider range of environmentally efficient products", but the Government's response concluded that such a change "has not been agreed, and nor does it appear likely to be, by other Member States". Nevertheless, the Government pledged to continue to press for changes in VAT that would "incentivise the purchase of energy efficient products and energy saving materials".

7.33. The Government have already had some modest successes, and VAT is charged at a reduced rate of five percent on the installation in residential properties of certain energy-saving materials, such as insulation. In Budget 2004 this concession was extended to ground source heat pumps, while in Budget 2005 the Chancellor announced a similar reduced VAT rate for micro-CHP and air source heat pumps. The Chancellor also undertook to "continue to negotiate with European partners to extend the categories of permitted reduced VAT rates to include energy-saving materials for DIY installations and energy-efficient products".[75] However, VAT at the full rate is still charged on a range of energy efficient goods—including windows, A-rated appliances, boilers and lighting.

7.34. Such changes could be combined with a more stringent regulatory regime for building extension and refurbishment. As the Action Plan notes, Building Regulations "can only be applied to the works in prospect. They cannot be used to oblige people to carry out work they did not propose for

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74 See the *Evening Standard* for 18 March 2005. See also the answer provided by Councillor Morris, of Lewisham Council, in February 2005 (http://www2.lewisham.gov.uk/lbl/CouncilMeetings/Committees_post0502/FullCouncil/documents/Feb2005/full_cncl_membersques_9feb05.pdf).

75 *Budget 2005, Investing for our future: Fairness and opportunity for Britain's hard-working families*, paragraph 7.28.

themselves—to improve the overall insulation of the existing structure for instance when undertaking an extension." (p 61) The passage of the Sustainable and Secure Buildings Act 2004, which broadens the purposes for which Building Regulations can be made, would allow more regulations to be made aimed at existing buildings, and the options for making use of this power have been one element in the Government's current review of Building Regulations.

7.35. Simply to impose additional costs upon property-owners, by requiring them to upgrade the entire building at the same time as extending it, could be a significant disincentive to extension and refurbishment. Therefore the power contained in the Sustainable and Secure Buildings Act must be used cautiously. However, if counter-balanced by other incentives, such as a reduction in VAT, an extension of Building Regulations could over time have a powerful impact on the energy efficiency of the building stock.

7.36. **We welcome the Government's commitment to arguing within the Council of Ministers for further revision of VAT rules in order to stimulate energy efficiency. The changes that have been agreed so far, such as the reduction of VAT on micro-CHP, are relatively peripheral. Far more important is the perverse effect of the current application of the full rate of VAT to building extension and refurbishment. We recommend that the Government redouble their efforts to persuade the European Union of the need to give strong fiscal signals to encourage energy efficient refurbishment of existing buildings.**

7.37. **We welcome the consideration that the Government have been giving to extending Building Regulations to cover existing buildings. However, in order to avoid creating a disincentive to building improvement, we recommend that the cost to property-owners of any extension of regulation in this area be offset by financial incentives such as a reduction in VAT.**

The Public Sector

7.38. According to the *Sustainable Development Framework for the Government Estate*, published from 2002-2004,[76] the Government estate comprises some 50,000 buildings, totalling 74 million m^2 (of which the vast majority is occupied by the Ministry of Defence). Overall environmental targets include a reduction in carbon emissions of 12.5 percent between 1999-2000 and 2010-2011, and a 15 percent improvement in energy efficiency (measured in kWh/m^2) over the same period. In addition, there is a target to source at least 15 percent of electricity from good quality CHP by 2010.

7.39. These are welcome targets. However, they may not in reality be quite as clear-cut as they appear. The CHP Association told us, for instance, that the huge National Health Service estate is in fact excluded from the CHP target (Q 663). Furthermore, generalised targets such as these do not necessarily reflect the opportunities that may exist in particular sectors—the current programme of renewal of school buildings, for instance, offers the chance to go beyond these relatively modest targets.

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[76] See http://www.sustainable-development.gov.uk/delivery/integrating/estate/estate.htm.

7.40. As far as new buildings are concerned, paragraph 136 of the Action Plan notes that the Government are "currently responsible for around 30 percent of new build spending", and continues by stating that they will "in future procure only buildings in the top quartile of energy performance for the central Government estate". Such procurement standards will apply to purchases, leases, or procurement through PFI.

7.41. This too is a welcome development. However, while public procurement policy can exert a considerable influence on the market for commercial property, we are unclear how much of the public estate is in fact excluded from the commitment to procure top quartile buildings for the "central Government estate".

7.42. **We welcome the Government's targets for sustainable development in the Government estate, in particular the announcement that they will procure only buildings in the top quartile of energy performance for the central Government estate. We agree with the Government in believing that this will have a marked effect on the wider commercial property market.**

7.43. **However, uncertainties remain over the coverage of these targets: for example, the target for central Government energy use contained in the Action Plan is not in itself adequate, given the huge size and the diversity of the public estate. We therefore look to the Government to extend their initiatives on procurement and energy use to all parts of the public estate as soon as possible.**

The Parliamentary Estate

7.44. The Parliamentary Estate presents unique challenges in terms of energy efficiency, and we therefore thought it appropriate to devote one public meeting to a discussion of current and possible future initiatives. Not only does the Estate include a World Heritage Site, and a Grade I listed building, but it is extremely heavily used, at unpredictable times, and by very diverse groups, including Members of both Houses, permanent staff, Members' staff and researchers, and visitors. It is also occupied and administered by two separate and independent organisations, though on a day-to-day basis the management of the Estate is the responsibility of the Estates Directorate, which serves both Houses. As a Committee of the House of Lords, our recommendations are necessarily directed to the House Committee and the House of Lords administration; however, some recommendations inevitably either have an impact upon the Commons, or are impossible to implement without co-operation with the Commons authorities.

7.45. The written evidence submitted by the Estates Directorate demonstrates Parliament's commitment to energy efficiency. The parliamentary Energy Policy commits both Houses to improving energy efficiency. There is a CHP plant at Canon Row capable of generating 150 kW electricity; new boilers have an operating efficiency of 82 percent, instead of the 45 percent efficiency boilers which they replaced; heat pumps are installed in 7/8 Old Palace Yard and the newest House of Lords out-building, Abingdon House; ten percent of electricity is derived from renewable sources. An Energy Group, chaired by an engineer from the Estates Directorate, provides advice and help to staff of both Houses.

7.46. However, the results achieved so far have been variable. From 1990-1991 to 2003-2004, degree-day adjusted energy consumption fell by 6 percent, from 378 kWh/m^2/year to 356 kWh/m^2/year, and the Director of Estates, Mr Henry Webber, expressed confidence that Parliament was "well on target to achieve the 10 percent target saving against the base line" for 2004-05. However, this achievement is undermined by an increase in electricity consumption since 1996-97 of around 50 percent (to some 159 kWh/m^2/year), thanks in particular the vastly increased use of IT equipment and the installation of air conditioning. As electricity is more carbon-intensive than the use of gas for heating, the net result is, in Mr Webber's words, "that we have not actually shown a reduction in carbon emissions" (Q 608). This contrasts with the Government's estimate that public sector emissions have fallen by 30 percent since 1990.[77]

7.47. Furthermore, in the course of our inquiry, on 16 February (the day the Kyoto Treaty came into force), thermal imaging photographs of the river front of the Palace were published in the media, along with photographs of other public buildings.[78] The photograph of the Palace vividly demonstrated the extreme difficulty of preventing heat loss from an old, historic public building. However, the Director of Estates, Mr Henry Webber, argued that this did not necessarily demonstrate waste—the windows along the Committee Corridor had been double-glazed, and were thus "as reasonably insulated as they could be", while those areas which showed brightest in the photograph were either yet to be double glazed (the Pugin Room, the Library) or were inherently difficult to insulate (the canvas tent on the Terrace).

7.48. The force of this defence is somewhat undermined by the fact that the double glazed windows in committee rooms, which are immediately above the heating units, can be found open more often than not, even when the temperature outside is below freezing. The explanation offered by Mr Webber on the day of our meeting was that an earlier committee had asked for the windows to be opened. In such circumstances, staff currently have no choice but to accede to the request.

7.49. This highlights a particular problem within Parliament—the many different categories of occupant. While instructions can be given to the staff of the two Houses, there is no simple way to control the behaviour of Members, and their staff and researchers. As Black Rod, Sir Michael Willcocks, told us, "I can order staff … to do things but I would not dream of trying it with your Lordships" (Q 614). Yet assuming air conditioning systems function correctly, there is no justification for double glazed windows, installed largely in order to improve energy efficiency, being wide open in the middle of winter. If Members request that they be opened, staff should be authorised to refuse their request. This will only be possible if domestic committees show strong leadership.

7.50. More broadly, we are not convinced that energy efficiency is a sufficiently high priority within the Administration. There is no mention of reducing energy consumption or carbon emissions within the House of Lords Corporate Business Plan; the annual budget for "tactical energy saving works", at £30,000, seems extremely low; and the monitoring of energy

77 *Review of the UK Climate Change Programme*, p 80.

78 See the *Evening Standard*, 15 February, and *The Times* and *Daily Express*, 16 February 2005.

consumption in various parts of the Estate, and the dissemination of data, in the form of monthly targets, seems rudimentary, and in marked contrast to the sophisticated monitoring of energy consumption we saw in Leicester or Gothenburg.

7.51. We also understand that the Energy Manager, who works within the Estates Directorate, is not devoted full-time to energy management. The annual spend on energy across the Estate is around £1.75 million, and the following comments from a recent report by the Welsh National Audit Office are therefore pertinent:

Best practice guidance recommends that a full-time manager should be engaged where energy expenditure exceeds £1 million per annum. This is based on one hour a week per £25,000 expenditure on energy, and reflects the general principle that these posts should be self-financing from the savings they can deliver.[79]

We have no doubt that within the Parliamentary Estate the scope for financial savings by means of energy efficiency would more than justify a full-time post, ideally at a more senior level than at present.

7.52. **We commend the authorities of both Houses for their achievements in controlling energy use within the Parliamentary Estate. However, we believe that Parliament should seek to set an example for the wider public sector. We therefore make the following recommendations to the House authorities:**

- **That the House of Lords Corporate Business Plan include specific targets for reducing energy use and greenhouse gas emissions, and that Office Business Plans incorporate specific initiatives to deliver these targets;**
- **That Black Rod's Office, together with the Serjeant at Arms' Department in the House of Commons, explore the feasibility of acquiring for Parliament an information system that would collect and monitor energy data, so as to facilitate real-time management of energy use;**
- **That regular reports on trends in energy consumption be presented to the appropriate domestic committees of both Houses;**
- **That, in accordance with best practice guidance, a full-time Energy Manager be appointed, and that his role be strengthened in order to reflect the higher prominence of energy within the House of Lords Corporate Business Plan;**
- **That the Energy Manager be tasked with strengthening the existing energy strategy, with a view to meeting the agreed targets;**
- **That domestic committees be invited to endorse the strategy and to establish clear guidance for both staff and Members on energy use;**

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79 National Audit Office of Wales, *Energy and Water Management in the Higher Education Sector in Wales*, March 2005, p 19.

- **That ambitious energy efficiency targets be incorporated into the project to prepare the Millbank island site for occupation by the House of Lords.**

CHAPTER 8: DEVELOPING MARKETS FOR HEAT

8.1. Demand for low-grade heat—that is, energy delivered at temperatures between ambient and the boiling point of water—for space and water heating represents a major proportion of United Kingdom energy demand. Domestic space and water heating alone comprise around a quarter of total United Kingdom energy end use.[80] The development of effective markets for such low-grade heat could thus deliver very significant carbon savings. These would arise principally as a result of:

- improvements in generating efficiency (in particular the use of Combined Heat and Power);
- the capture and use of waste heat from electricity generation and industrial processes;
- increased use of carbon-free biomass fuel;
- greater opportunities to capture and store carbon emissions.

8.2. While not all these potential benefits are explicitly to do with energy efficiency, they are closely interlinked. United Kingdom energy policy has hitherto consistently overlooked heat, concentrating instead on electricity, industrial processes and transport. For example, there is no concerted attempt to collect and use the huge quantities of heat produced by the United Kingdom's power stations, located as they mostly are away from major population centres. As a result, while their electrical output in 2003 was some 398.8 TWh, their fuel inputs totalled 1,031.1 TWh—thus no less than 632.3 TWh of energy were lost, largely in the form of heat dispersed via cooling towers.[81]

8.3. The omission of heat from the policy mix is also apparent in the relative neglect of thermal solar energy, which, though offering significant efficiency gains when compared with the conversion of solar energy into electricity by photovoltaic cells, enjoys neither the same public recognition nor the same fiscal support, through the Renewables Obligation.[82] Nor has there been any commitment by Government to the development of markets for heat, with the result that, by contrast with other European countries, no significant heat market has developed in the United Kingdom. We therefore take this opportunity to explore these wider issues. In so doing we draw extensively on the work of the Royal Commission on Environmental Pollution (RCEP), which has repeatedly argued for such initiatives.[83]

8.4. We have pointed out in Chapter 6 that new construction technologies can greatly reduce the demand for space heating, ultimately leading to "passive" buildings with no dedicated source of heating. However, such buildings will make up no more than a small proportion of the building stock in coming decades, so the demand for low-grade heat will continue for the foreseeable future.

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80 Source: Dr Sinclair's paper, Table 1; Digest of UK Energy Statistics (http://www.dti.gov.uk/energy/inform/energy_stats/total_energy/dukes1_1_5.xls). See also paragraph 6.5.

81 Written answer by the Lord Sainsbury of Turville, 20 June 2005, WA 152.

82 See written evidence from Solar Thermal.

83 See in particular the 22nd report, *Energy—the Changing Climate*, 2000 (Cm 4749) and the special report *Biomass as a Renewable Energy Source*, 2004.

8.5. Such heat can be produced from domestic sources which are essentially carbon-free and readily available, thereby simultaneously contributing to the objectives of reducing carbon emissions and dependence on imported energy. Furthermore, heat distribution can be associated with low operating costs and could therefore contribute to reducing fuel poverty. In addition to use of waste heat from electricity generation, there are major carbon-neutral sources in the form of biomass, from agricultural and forestry waste and energy crops, and solid waste.[84] Because of their low density, biomass and waste are most effectively used locally as fuels for CHP or heat-only plants. Absence of markets for heat has been identified by the RCEP as one of the principle reasons why bioenergy has not developed in the United Kingdom in the way it has elsewhere in Europe.

8.6. Community heating schemes, distributing low-grade heat in urban areas, were installed in parts of the United Kingdom from the 1950s to the 1970s. However, poor technical performance gave them a bad image, and contributed to an aversion to supply systems which appear not to be under the control of individual householders or building occupiers.[85] Resistance to community heating has continued in construction and development. For example, Mr Hornby, of the House Builders Federation (HBF), told us that he could see no advantages in community heating for individual customers: "With the district heating schemes you have got the potential for losing energy through distribution ducting to the properties. There is no pull factor at the moment for the new house building industry" (Q 229).

8.7. This seems to be a further example of the inherent conservatism of the construction industry. In fact, the technology of heat provision has developed since the 1970s. Community heating is established practice in urban areas throughout Northern and Central Europe. We were told, for example, in the course of our visit to Gothenburg, that losses from the entire 700 km-long network amount to just 7-8 percent, comparable to the losses in distribution and supply of electricity and far too small to negate the advantages of distributing heat from low-carbon sources.

8.8. The conservatism of the construction industry is compounded by lack of leadership by central Government. The proposed development of new housing in the south-east of England, much of it of high density, offers an extraordinary opportunity to develop community heating. However, the design and construction of new housing is now left almost entirely to private companies—in 2003, of almost 190,000 new houses across the United Kingdom, private enterprise was responsible for over 171,000, registered social landlords some 18,000, and local authorities just 241.[86] As the RCEP has pointed out, community heating schemes are most cost-effective when incorporated into residential and commercial developments at the design stage.[87] However, in the absence of the granting of clearer guidance and stronger powers to planning authorities on the provision of community

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84 "Quantification of the Potential Energy from Residuals (EfR) in the UK", study by Oakdene Hollins Ltd., for the Institution of Civil Engineers and The Renewable Power Association, March 2005 (http://www.r-p-a.org.uk/content/images/articles/RPA&ICEEfRW.pdf).

85 See "A strategic review of the Community Energy Programme", Final Report to the Energy Saving Trust by IPA Energy Consulting and e2S Energy and Environment to Sustainability, December 2003.

86 Source: ODPM: http://www.odpm.gov.uk/stellent/groups/odpm_housing/documents/page/odpm_house_604055.xls.

87 *Biomass as a Renewable Energy Source*, paragraphs 4.18-4.22.

heating, it appears inevitable that lower-cost solutions will be preferred, regardless of their long-term impact on energy consumption—a specific example of the general problem identified in paragraph 3.16.

8.9. **We recommend that ODPM encourage local authorities and developers to incorporate community heating as standard in all new build projects.**

Technology of heat provision

8.10. The heat supply system in Gothenburg is typical of current technology. During periods of base load demand—the summer months—the system runs on waste heat from industrial installations including CHP. At other times of year, additional heat is provided by combustion of non-renewable solid waste (which is stored over the summer) or renewable biomass. During periods of particularly cold weather, additional heat is provided by dedicated heating plant fired by oil or gas; this is the only source of non-renewable carbon emissions from the system. The heat is distributed by hot water, pumped through pipes running under the streets. Buildings are connected into this system via heat exchangers which heat up a separate water flow circulated within the central heating system of the building. The heat exchanger is usually located outside the building, typically underground, so that no space within the building is needed for heating plant.

8.11. The size of the area covered by heat distribution is not in itself a technical constraint; for example, in Gothenburg the network is some 700 km long, with a radius of 20-30 km. The key technical issue is the density of heat demand. As part of a study carried out for the Carbon Trust,[88] Community Energy Heat Maps have been prepared "to identify opportunities for community heating" by showing "demand for heat from homes, public sector and commercial buildings, for every postcode area in the UK".[89] The information needed for planning community heat provision is thus already available.

Barriers and policy measures

8.12. The most important practical and economic barrier to community heating schemes is the initial capital cost. Ongoing costs are much lower: experience in Northern and Central Europe suggests that, once established, heat distribution systems can be expanded by connecting additional sources of waste heat or dedicated heat or CHP plant, although upgrading existing systems may require replacement of piping and insulation.

8.13. To overcome this barrier to entry requires positive action to promote a market for heat. The Community Energy Programme (CEP), launched in 2001, is intended to support the development of sustainable community heating in the United Kingdom. The programme is jointly managed by EST and the Carbon Trust on behalf of Defra. Initially the programme had £48 million available for capital grants and £2 million for development support for the period from April 2002 to March 2004, subsequently extended to March 2005 and most recently to March 2008. However, like other actions

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88 "The UK Potential for Community Heating with Combined Heat and Power", study by BRE for The Carbon Trust, February 2003, reviewed November 2003.

89 The maps area available online at www.est.org.uk/communityenergy/ukpotential/heatmaps.cfm.

explored in this report, the success of the programme has been constrained by low energy prices. We note the conclusion of the IPA study that future prices for both gas and electricity are likely to be higher, so that community heating schemes are under-valued by basing long-term calculations on current energy prices. We have also noted that concentration on capital cost without considering the lifetime costs of operating buildings can lead to perverse decisions. Community heating schemes are associated with high capital costs relative to their operating costs. Therefore we regard CEP as an area where it is particularly important for the Government to apply their own recommendations as embodied in the Treasury's "Green Book".

8.14. **We endorse the recommendation of the IPA study that the Community Energy Programme be extended. However, we note that the programme has had limited impact so far, and that commercial barriers to the take-up of heat provision must also be addressed.**

8.15. The first such barrier is simply the lack of demand. We noted above that there is a reluctance, notably in the construction industry, to contemplate community heating and that this flies in the face of experience elsewhere in Europe. While some potential users see the attraction of community heating (for example, retailers in Leicester have been attracted by the fact that heat provision removes the need to allocate space for heating plant), the message has not been universally accepted. Thus in Durham, for example, the University is currently decommissioning a small community heating system that has provided heat to buildings on the Peninsular since the 1950s: the inefficiency of the system itself, compounded by the fact that there is no demand other than from University-owned buildings, make the system hopelessly uneconomic. When we visited Woking, in the course of our recent inquiry into renewable energy, we learnt that a developer in the centre of the town had chosen to install electrical heating in a new block of flats rather than taking heat from the Council-run CHP plant across the road.

8.16. The schemes supported so far under the CEP are significant but limited in scale, mostly to single institutions or developments. We therefore see a clear need for a few larger scale developments which can be promoted as demonstrations of the value and potential scope of heat provision. We noted in Chapter 4 the need to make such projects simpler to finance, so that local authorities do not perceive them as risky. Such projects should demonstrate the application in the United Kingdom of technology which is already commonplace elsewhere in Europe. Therefore support for such demonstration projects should not be contingent on demonstrating novelty.

8.17. In addition to capital grants or incentives, low-carbon heat provision should logically be treated consistently with low-carbon electricity provision. Whereas demand for electricity varies on a daily cycle, demand for low-grade heat varies on a different cycle, which is both daily and yearly. This creates particular problems for CHP, where electricity generation is essentially a by-product of heat production, and is therefore in effect intermittent. As Mr David Green, Director of the CHP Association, told us, this subjects CHP to penalties under the New Electricity Trading Arrangements (NETA) balancing mechanism. Whereas the Renewables Obligation protects renewable generators to an extent from such penalties, CHP remains "fully exposed to NETA" (Q 672).

8.18. The lack of any incentive for heat markets resembling the Renewables Obligation is evidence of the point made at the beginning of this chapter, that energy policy has persistently overlooked the fact that heat is a form of energy. We note that the Government continue to commission studies of the practicalities of developing markets for heat.[90] In light of these studies, **it is time for the Government to progress from analysis to action in promoting markets for heat, particularly from renewable sources, and we so recommend.**

8.19. Finally there is the issue of energy services. Experience elsewhere in Europe is that households and businesses connected into a community heating scheme tend to be so satisfied that they do not seek to change heat supplier. Therefore, even if the "28-day rule" applied to heat provision, users of community heating see themselves as participants in a long-term arrangement. This leads us to conclude that the energy service function could also be applied to community heating systems.

8.20. An Energy Services Company (ESCO), in providing a range of energy management services, functions as the interface between the supplier of primary energy and the end user. Furthermore, because energy management is their business, ESCOs are inevitably aware of the life cycle costs of energy provision even where they may not be a high priority for building occupants and managers. An ESCO associated with a community heating scheme could in principle establish long-term contracts to provide services for a number of commercial and domestic premises, monitoring energy use, supplying both heat and energy efficient products, and so on, while purchasing primary energy from a range of sources. This would allow the establishment of an economic base large enough to be commercially attractive.

8.21. In the case of Poseidon in Gothenburg, an ESCO has been able to design, build, finance and operate heat distribution systems, working with the local authority and the primary energy supplier to mutual benefit. In the case of the Berlin Energy Agency, application of the ESCO model has stimulated €37 million of private sector investment in energy saving measures, cutting the city's fuel bills and saving some 27,000 tC in emissions. We therefore welcome the announcement on 20 June that London is to establish its own Climate Change Agency, which, in the words of a press release, is intended to "establish itself as a municipal company—in partnership with private sector firms—which will design, finance, build and operate low and zero-carbon capacity".[91]

8.22. **We recommend that the Government explore the application of the Energy Services model to community heating. In particular, we believe that the establishment of the London Climate Change Agency offers a welcome opportunity to apply such a model on a large scale, with corresponding gains in energy efficiency and emissions.**

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90 Ilex Energy Consulting, "Possible support mechanisms for biomass-generated heat" (December 2003); Future Energy Solutions, "Study of the economics of example CHP schemes" (July 2004).

91 See http://www.london.gov.uk/view_press_release.jsp?releaseid=5234.

CHAPTER 9: APPLIANCES

9.1. The title of this chapter is a catch-all, covering "cold" appliances (refrigerators and freezers), "wet" appliances (washing machines, etc.), "brown" appliances (televisions, computers, etc.), lighting and cooking appliances. Taken together these represent around 17 percent of domestic energy consumption. As the vast majority of this consumption is in the form of electricity, appliances represent a rather higher proportion—around 25 percent—of domestic carbon emissions. We do not have comparable data for commercial or office buildings, but as reliance on electricity, particularly for computers, air conditioners, and so on, is relatively higher, it is likely that "appliances" represent a significantly higher proportion of energy use overall. In the retail sector refrigeration, in particular, is also a major source of energy consumption.

9.2. Within this sector technological development has been a double-edged sword. On the one hand, considerable progress has already been made in improving the efficiency of standard household appliances: for instance, an "A-rated" refrigerator today consumes around 140 kWh/year, compared with some 400 kWh/year for a 10-year-old model.[92] At the same time, new products are constantly being developed and marketed—the expansion in IT, plasma television screens, set-top boxes, and the increasing miniaturisation of much of this equipment, which brings with it the inefficiencies of rechargeable batteries, have more than outweighed improvements in more traditional appliances. Overall, energy consumption by appliances continues to rise.

European Union product standards

9.3. The improvement in product standards in recent years has been driven in part by regulation, through the EU energy labelling scheme, which was introduced in 1995, and is mandatory for domestic refrigerators, washing machines, tumble dryers, washer dryers, dishwashers, lamps, electric ovens and air conditioners. The label itself was praised by Mr Meier, of the IEA, as "probably the best label in the world" (Q 434). The prominently displayed central rating, on the scale of A-G, has exerted a strong influence on both purchasers and manufacturers, encouraging them to gravitate towards higher-rated equipment.[93] Detailed data on energy consumption are also included, though less prominently. There is some latitude allowed as to additional information—in Germany, for instance, data on the financial cost of such consumption are also included.

9.4. However, as Mr Meier also pointed out, "making and maintaining an energy label is a dynamic process and one cannot simply make a label and stop". The ratings A-G reflect not absolute energy consumption, but consumption relative to other appliances within the market. As energy efficiency generally improves, logic dictates that the ratings should be reassessed, to avoid all appliances falling into in the A or B grades. Mr Meier believed that the European Commission "did not have sufficient staff or the independence to be able to do the reclassification". The result, under "political pressure by

92 Action Plan, p 105.

93 The market share of "A-rated" wet appliances has risen from zero in 1996-97 to over 50 percent in 2003-04. See Action Plan, p 63, Figure 8.

the manufacturers”, was that instead of assigning new values to the existing grades, two new grades, A+ and A++ were introduced. This “greatly undermined the credibility” of the scheme (Q 434). We agree: the existence, largely unadvertised, of A+ and A++ grades renders the labelling scheme misleading and close to worthless.

9.5. In marked contrast, a useful report from the British Embassy in Tokyo drew attention to the dynamic Japanese “top runner” scheme, which was introduced in 1998. The principle of this scheme, which has also been adopted in Australia, is simple: the most efficient appliance on the market is identified as “top runner”, and becomes the standard to bet met by all appliances of that type within a specified timescale. Experience has shown that Japanese manufacturers have been extremely proactive in meeting these requirements, though importers have struggled. “Top runner” standards apply to almost all home appliances (including televisions, excluded from the EU scheme), as well as to passenger and freight vehicles.

9.6. Two further issues arise with regard to the energy labelling scheme: first, whether the standards themselves are sufficiently high; and second, whether the scheme should be extended more widely.

9.7. On the first of these points, Mr Meier, in a presentation to our seminar in October 2004, pointed out that for a range of products the energy efficiency requirements in Europe are less stringent than those in certain other countries, particularly in the far East and North America. This point was confirmed by Lord Whitty, who conceded that “EU standards, in some areas at least, are nowhere near as good as the American and Japanese standards”. The risk is therefore that the European Union is in effect becoming a dumping-ground for less efficient goods, while better quality goods are sold in more advanced markets (Q 757).

9.8. The Minister’s explanation of these effects was unconvincing. He argued, for example, that if “markets for higher standard goods around the world were greater” then manufacturers would inevitably raise product standards “irrespective of whether the individual countries were requiring those standards through a mandatory system or not” (Q 758). We cannot follow the logic of this argument. As long as manufacturers can sell lower standard goods at lower cost in the European Union, rather than investing in product development, new production lines, retraining, and so on, they will do so. However, Lord Whitty did confirm the Government’s commitment to improving European standards, both through negotiating higher mandatory requirements, and through voluntary agreements with manufacturers. The main tool for the latter, which we discuss below, is the Defra-sponsored Market Transformation Programme.

9.9. The second issue is whether the energy labelling scheme should be extended more widely. The list of products currently covered is a very traditional one, and there is a risk that it will fail to keep pace with consumers’ spending on energy-consuming goods. A particular area of concern is the market for IT equipment and televisions, which continues to expand and develop rapidly. The industry itself is resistant to energy labelling: as Mr Peter Evans, of Sony, told us, “The major reason … is because there are so many functions within … a TV that to actually be able to compare an apple and an apple in terms of a TV set become very difficult … 100 Hz which gives you a flicker-free picture, the sound quality—these aspects that make the picture quality better do tend to impact on the energy consumption” (Q 461).

9.10. Mr Evans and his colleague Mr George Fullam, of the trade association Intellect, instead drew attention to the "Energy Star" scheme, an initiative that originated as a result of public procurement policies in the United States, whereby manufacturers of office equipment, such as PCs, photocopiers, and so on, commit themselves to meeting certain minimum standards for energy consumption in use, in standby mode, and for predicted yearly average consumption in normal use. Mr Evans asserted that this demonstrated that the industry was "trying to … make the consumers aware of what the energy impact is and get them to make a balanced choice". However, while the Energy Star scheme has the merit of having an international coverage, and, by an agreement reached in 2003 between the United States and the European Council, is now administered within Europe by the European Commission,[94] he conceded that within the United Kingdom it still covered, depending on the kind of product, only between 40 and 70 percent of the market. We do not regard this level of coverage as sufficient to enable consumers to make balanced, well-informed decisions; nor do we believe that it is an adequate substitute for the mandatory and universally recognisable EU energy label (QQ 460-461).

9.11. The draft EcoDesign of Energy Using Products Framework Directive, which was adopted by the European Parliament on 13 April, would enable the Commission, assisted by Member States, to bring forward requirements to improve the environmental performance of a potentially wide range of products throughout their life. At the time of writing, no finalised text of the Directive was available, but it is clear that in principle the application of a life cycle assessment to all stages of product design, use and ultimate disposal, offers the possibility of major gains in efficiency. However, we have already alluded to Mr Meier's comments on the lack of resources and expertise available to the Commission in implementing higher standards, and there must be doubts over the ultimate effectiveness of this ambitious proposal (Q 407).

9.12. **Product labelling, to be effective, must be dynamic, reflecting technological innovation and product improvement. The EU energy labelling scheme, for all its past success, is in danger of becoming outdated and inflexible. The decision to introduce "A+" and "A++" ratings fundamentally undermines the scheme's integrity, while European product standards lag behind those in the far East and North America.**

9.13. **We therefore urge the Government to use their forthcoming EU Presidency to engage with the European institutions and Member States in strengthening and extending the mandatory labelling scheme. This process should include an investigation into whether the EU Commission has sufficient resources to implement and update the scheme adequately. It should also include consideration of comparable schemes elsewhere in the world, such as the Japanese "top runner" scheme, and their applicability within the EU.**

9.14. **We welcome the Government's commitment to securing agreement to the EcoDesign of Energy Using Products Directive, and look forward to progress in this area. We recommend that the provisions of the**

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[94] See http://www.eu-energystar.org/.

Directive be used to establish challenging minimum standards for a wider range of energy using products.

9.15. **We also urge the Government to argue the case for extending the existing, standardised labelling scheme to a wider range of products, including IT equipment and televisions.**

Market transformation

9.16. The imposition of minimum standards, and mandatory labelling, is only part of the story. Equally important is the process of "market transformation", a less easily defined process in which Government and industry work together on improving standards, engaging in technical analysis, research and product development. The principal agency engaged in this task in the United Kingdom is the Market Transformation Programme (MTP).

9.17. The MTP, which is funded by Defra and DTI, was described by Mr Paul White, of AEA Technology, as a "consortium of experts" (Q 471), drawn from industry, trade associations, research bodies, and so on. Its objective is to "improve the eco design performance and, therefore, the energy performance of products over time" (Q 468). However, our questioning of Mr White and other members of this consortium yielded only the most nebulous sense of how the MTP is organised, how it goes about its work, and how it measures success or failure (see QQ 468-488). Anecdotal evidence suggests further that the MTP has a low profile in wider manufacturing industry.

9.18. The clearest indication we were given of what the MTP does was by means of an example, that of the set top box. In Mr White's words, "As the product came to the market the first thing that we did was to identify a problem; the second was to bring together the market players… and the third was then to go forward and influence the direction of European policy to enable mitigation of growth of consumption from that product" (Q 476). The result was that the average energy consumption of set top boxes had been reduced from 27 to 12-15 watts (Q 488).

9.19. The key word here is "mitigation". As Mr White and his colleague Mr Robert Harrison, explained in the context of the MTP's overall targets, the objective appears not to be to reduce actual energy consumption, but to "mitigate" the increase in energy consumption that would otherwise arise from the development of new products (QQ 484-486). The MTP is an exercise in damage limitation.

9.20. In contrast, when we visited the Ministry for Sustainable Development in Stockholm, we were given a far clearer and more dynamic definition of market transformation: in the words of Mr Arne Andersson, it was "the art of buying what is not available". The steps in the Swedish procurement process were: to define a need; to identify a technical solution and a supplier capable of providing it; to establish a strong group of buyers willing to invest in the new product; and then to bring suppliers and buyers together to develop a dialogue, and ultimately a market demand. Once winners in such procurement processes have been identified, there are prize ceremonies, information campaigns to secure wider acceptance, and if necessary initial subsidies.

9.21. **The Market Transformation Programme is too reactive, too nebulous in organisation and working methods, and too unfocused in its objectives and measures of success. We therefore recommend that the Government review the effectiveness of the MTP, with a view to giving more dynamic and effective leadership to the process of market transformation.**

Risk areas

9.22. Consumers have an apparently limitless appetite for new energy-using products. We are not in a position to predict what new products will emerge in the coming years, but have considered two sectors where there has already been considerable expansion, which is likely to continue, and which present a significant risk to the Government's attempts to reduce energy use.

9.23. The first of these sectors, which has already been mentioned, is information and communications technology. At our seminar it was asserted by Professor Brenda Boardman, of the Environmental Change Institute, that the expansion of this sector could swallow up all efficiency gains in other sectors. While it is difficult to put firm figures on such possibilities, and Mr Fullam indeed claimed that "smart design" would lead to a "steady reduction in power consumption", he did also concede that consumer electronics were still an "immature market" (QQ 442, 441).

9.24. The improved efficiency of individual products is unquestionable: as Mr Fullam pointed out, a 19 inch colour television in the late 1960s would consume "something like 525 watts"; an equivalent television today consumes around 60 watts. The problem is not that individual products have failed to improve, but that new products—televisions with larger screens, wall-mounted televisions, flicker-free screens, plasma screens, and so on—have emerged, creating a hugely expanded, diverse market, in which the relative energy efficiency of products is a negligible factor in customer choice.

9.25. One area of particular concern, which is relatively well documented, is the proliferation of devices which, when not in use, are left in standby mode. As Mr Meier pointed out, power consumption for audio devices in standby mode can vary between one and 25 watts. But, as he continued, "there is no way for a consumer to know which uses 25 watts and which uses one watt" (Q 405). While products bearing the Energy Star label do provide such data, we have already commented on the limited scope of this scheme. Nor are such data in themselves necessarily enough: the consumer's ignorance is all too often compounded by aspects of product design, such as the lack of a simple on/off switch on the front of most personal computers. How many computer users realise that unless they switch off the power supply at the wall their PC will continue to consume electricity?

9.26. The effect of standby consumption, at a national level, is breathtaking: in the United Kingdom television sets alone consume some 90 million kWh per month in standby mode.[95] This is approximately equivalent to the continuous output of a small—120 MW—power station. It translates into greenhouse gas emissions approaching 150,000 tC/year. Moreover, these figures apply only to televisions, and fail to take account of all the other

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[95] Source: Written Answers by Lord Whitty, 3 March 2005 (WA 45) and Lord Bach, 23 June 2005 (WA 187-190).

forms of equipment—audio equipment, video or DVD players, computers, photocopiers—which revert to standby mode when not in use. The Government estimate that overall no less than 760 million kWh per month of electricity are consumed by appliances not actually in use—the equivalent of 1 GW continuous output, or some 2.25 percent of total United Kingdom electricity consumption, producing of the order of 1.2 MtC per annum.[96]

9.27. The Government's approach to these problems is to encourage manufacturers to reduce power consumption through an EU-wide voluntary code of conduct, best practice guidelines and targets. In addition, the Government's own procurement policies require that departments should specify televisions with standby power consumption of less than one watt. Such an approach appears to overlook the possibility of using regulation to enforce improvements in design and the provision of better information for consumers.

9.28. **The fast-growing, diverse market for consumer electronics presents a serious a risk of uncontrollable rises in energy consumption. The Government's reliance on voluntary codes and best practice guidelines, while it may deliver improvements in certain areas, is a piecemeal and fundamentally inadequate response to this threat. We therefore recommend that the Government examine the feasibility of setting minimum standards for this sector, as well as requiring better information for consumers, for example on standby power consumption.**

9.29. The second danger area we looked at was the growing demand, particularly in the context of climate change, for air conditioning. An extremely clear summary of the state of the air conditioning market was provided by Mr Ray Gluckman, of the Institute of Refrigeration: though demand for air conditioning has grown significantly in the last 20 years, it remains an immature market, with only around 10 percent of non-domestic floor space air conditioned (around 15 percent for offices). Penetration into the domestic market is minimal, at under one percent. It is estimated that in the coming 20 years the non-domestic floor area that is air-conditioned will triple (representing growth of around six percent per annum); the domestic market will grow more quickly in percentage terms, but from a much lower base, with the result that in terms of carbon emissions its effect will be relatively minor.[97] While the efficiency of appliances is improving constantly, Mr Gluckman accepted that "it does look inevitable that the market growth will overtake the efficiency improvements" (QQ 440, 452).

9.30. Mr Gluckman's conclusions demonstrated the industry's willingness to embrace regulation and mandatory standards—perhaps a result of its long experience of such regulation in the field of refrigeration. He described "a great need for intervention", including minimum efficiency standards by means of a "rating system" (at present, domestic air conditioners carry an EU energy label, but those used in commercial premises or offices do not).

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96 Carbon emissions calculated by reference to Dr Sinclair's calculation of the carbon intensity of electricity generation in 2003 (see Appendix 4).

97 An ODPM consultation paper on the impact of climate change upon Building Regulations, which extrapolates data from the United States, estimates that if the temperatures seen in 2003 became the norm, "ownership might rise to between 30 and 40 percent of households in the South East". However, at 2003 temperatures the actual energy consumption for whole-house cooling of a moderately sized dwelling would be only around 30 kWh per year ("Building Regulations Part L: Adaptation Strategy", pp 15-16).

There also had to be more detail in Building Regulations, to ensure that speculative developers were "not allowed to put in inferior systems and inferior controls". Perhaps most strikingly, he accepted that there needed to be "some sort of market avoidance policy" (QQ 446, 456, 453).

9.31. **The projected trebling over the next 20 years of the floor area in commercial or office buildings that is air conditioned has serious implications for future energy consumption. We welcome the willingness of the air conditioning industry to engage in discussion on minimum efficiency standards and the development of Building Regulations, and recommend that the Government address these issues as a matter of urgency.**

CHAPTER 10: INDUSTRIAL ENERGY EFFICIENCY

10.1. Industry's share of the United Kingdom's energy end use has declined sharply in the last 35 years. Whereas in 1970 industry (including construction) consumed over 700 TWh of energy, in 2002 this had fallen to around 400 TWh.[98] At the same time transport and domestic sectors had overtaken industry as end users of energy, with the result that industry now represents just 22 percent of United Kingdom energy use.[99] This decline is in large part due to structural change, in particular the decline of traditional, energy intensive manufacturing industries such as steel.[100] Many of these industries have in effect been exported, raising the possibility (which is beyond the scope of this inquiry) that structural change in the United Kingdom economy, while generating a reduction in our emissions, has in fact contributed to an increase in global emissions.

10.2. However, major improvements in industrial energy efficiency have also played a part. Many individual companies have made commendable efforts to promote sustainability and energy efficiency, and to develop the use of alternative energy sources. In addition industry as a whole, as well as being subject to the vagaries of energy prices and international competition, has been the object of more concerted pressure to improve energy efficiency than any other sector. Indeed, we got the sense that many in industry feel almost victimised: as Mr Farrow said, "it is the business sector that has pretty much delivered the Kyoto targets, whereas if you look at … household emissions and private transport, there has barely been any change at all" (Q 585). We have some sympathy with this view.

10.3. Nevertheless, the Action Plan forecasts further savings of 3.8 MtC/year between now and 2010 from energy intensive industries. The Climate Change Programme Review, in contrast, states that greenhouse gas emissions from "industrial processes" were 11.8 MtC in 2000, will be 11.4 MtC in 2005, falling only to 11.1 MtC in 2010 and remaining stable thereafter. The term "industrial processes" does not of course cover all emissions from energy intensive industries—transport, for example, is a significant contributor. However, the difference between the hypothetical saving and the absolute figure further illustrates the difficulty in translating the Government's energy efficiency targets into absolute emissions levels.

Climate change instruments affecting industry

10.4. The Climate Change Levy was introduced on 1 April 2001. Despite its name, it is a tax not on greenhouse gas emissions but on the use of energy, including a levy of 0.43p/kWh on electricity use. The Levy is designed to be revenue neutral—that is to say, revenues realised by the levy are recycled to employers, largely by means of a reduction in National Insurance

98 Action Plan, p 34, Figure 4.

99 Source: Digest of UK Energy Statistics (http://www.dti.gov.uk/energy/inform/energy_stats/total_energy/dukes1_1_5.xls).

100 The IEA/OECD's *30 years of energy use in IEA countries* shows a broadly similar pattern for all developed economies: total manufacturing energy demand in IEA countries fell by 15 percent from 1973-2000, largely as a result of structural change. However, of the IEA-11 countries, the United Kingdom showed the lowest average rate of increase in manufacturing output (with the exception of Norway), and the highest rate of reduction in manufacturing energy use (see Figure 4-7).

contributions. Domestic users and small businesses are exempt from the Levy.

10.5. The Levy was from the first supplemented by Climate Change Agreements (CCAs) with specific energy intensive industries. Initially the ten most energy intensive sectors, through their respective trade associations, were targeted: aluminium, cement, ceramics, chemicals, food and drink, foundries, glass, non-ferrous metals, paper, and steel. However, CCAs now cover no fewer than 44 sectors. CCAs provide an 80 percent discount from the Levy for sectors that agree ten-year targets for improving energy efficiency or reducing carbon emissions.

10.6. In addition, there is the voluntary United Kingdom Emissions Trading Scheme, which began in 2002. This scheme, entered into by 31 direct participants, ranging from large corporations to local authorities and museums, operates, like the European Union Emissions Trading Scheme (EU ETS), through the buying and selling of carbon allowances, which reduce year by year. Participants are thus able to decide on the most economic way to meet their obligations—either by reducing energy use, or by purchasing allowances from other participants, who have exceeded their target. The first phase will come to an end in 2006, and the United Kingdom has already secured approval from the Commission for participants to opt out of the EU ETS until this time. At this time participants will transfer to the EU scheme.

10.7. The first phase of the EU ETS itself came into effect in January 2005, and will run for three years. The White Paper described it as "a central plank of our future emissions reduction policies" (p 29), and the Climate Change Programme Review announces that "We are showing our commitment to the EU ETS by setting a cap on allowances in the first phase (2005-2007) that takes use beyond our Kyoto target" (p 34). Given that the United Kingdom has already exceeded its Kyoto target, this self-congratulation is somewhat disingenuous.

10.8. This complex array of policy instruments begs a number of questions, which fall under two broad headings:

- Do the various instruments collectively form a coherent whole?
- What is their likely impact on industry?

Coherence

10.9. The Climate Change Programme Review acknowledges that there is "considerable overlap" between the coverage of these various schemes, and one of its stated objectives is to address this overlap so as to achieve the right "future policy mix of measures impacting on business". It notes that "there may be a case for maintaining existing national policy measures, in particular CCAs and the UK ETS … to ensure that the full potential for business sector emission reductions is achieved." However, it also concedes that "some business stakeholders have argued for greater simplicity" (p 50).

10.10. The Government are also well aware of specific pitfalls. For instance, the Review states that "the UK will be putting an application to the Commission for the temporary exclusion of installations covered by a CCA for the first phase, but they must join after 2007." However, this application itself begs a number of questions. What practical impact will EU ETS have on British industry, given that 44 sectors are excluded? And what will happen after 2007, given that CCAs run until 2010?

10.11. The potential for overlap is compounded by the different measures applying to the various instruments. The Climate Change Levy is a tax on energy use, which therefore, despite its name, encourages reductions in energy demand rather than targeting carbon emissions *per se*. Indeed, while certain forms of electricity generation, notably renewables, are exempt from the Levy, electricity generated from nuclear power, even though it does not impact upon the climate, is subject to the Levy. CCAs, in contrast, reflect the diversity of the sectors covered (and further illustrate the need for a clear definition of energy efficiency): for most sectors targets are expressed in terms of primary specific energy consumption, but for certain industries, notably aluminium, targets are expressed in terms of reduced carbon equivalent emissions.

10.12. The UK ETS sets allowances in terms of carbon equivalent emissions, and covers all the main greenhouse gases. Phase 1 of the EU ETS, on the hand, sets targets only for carbon dioxide emissions, though it is anticipated that Phase 2, coming into effect in 2008, will set targets for the entire basket of greenhouse gases.

10.13. Another layer of complexity could be added by the proposal, floated in the Climate Change Programme Review, for "white certificate trading"—that is to say, tradable commodities representing amounts of energy saved, or avoided. The Review acknowledges that before such a scheme is introduced many issues would need to be considered, including "the monitoring and verification of efficiency gains, the establishment of baselines from which to measure improvement and the interaction with other policies and measures" (p 52).

10.14. The views of industry on the interaction between these various instruments were scathing. The British Cement Association (BCA) described the interaction of the Levy and EU ETS as "a burdensome bureaucratic duplication of effort, which does nothing to further reduce CO_2 emissions. There are two different monitoring systems and the rules for interactions between the two … are convoluted and unnecessarily complex" (p 216). Dr David Welsh, of the CBI, warned of "all sorts of bureaucracy and complications" (Q 577). Dr David Harris, Secretary General of the Aluminium Federation (Alfed), also described the Levy as "bureaucratic" and "costly to administer", and warned that the relationship between it and the EU ETS had been "poorly planned" (Q 587).

10.15. At the same time, our witnesses agreed that carbon trading was in principle the best and most cost-effective way to promote reduced emissions from industry, and much to be preferred to direct taxation. As Mr Farrow said, political leaders should "make a policy decision" about the desired level of emissions, "and then the trading system should use the market to drive those reductions out at the cheapest cost". In contrast, rising energy prices, while they might trigger action in individual cases, would heavily penalise energy intensive industries which had already invested heavily in energy efficiency, and therefore could not make significant further gains—for them, it would just be "an added cost in very competitive markets" (QQ 575, 573).

10.16. **We agree with our witnesses that the multiplication of schemes to promote industrial energy efficiency has been poorly planned, and is likely to be burdensome and bureaucratic. We urge the Government to make a long-term commitment to consolidating these various schemes under the EU Emissions Trading Scheme, which is likely to be the most cost-effective route to emissions reductions.**

10.17. **We view the Government's apparent support for "white certificate" trading with serious concern: the introduction of yet another set of trading arrangements, incorporating yet another measure (in this case, targets for energy efficiency) is a recipe for still more confusion. What is needed is a period of policy consolidation and clarification, not the over-layering of existing policies with new targets and incentives.**

Impact

10.18. As we have already noted, the focus of Government policy hitherto has been the energy intensive industries, which are generally covered by CCAs. However, while energy intensive industries may look like low-hanging fruit, there are problems. Mr Gilbert, of the BCA, noted that energy represents 35 percent of the cement industry's costs. Thus reducing energy use is inevitably a much higher priority for the industry, even without Government intervention, than it would be for an industry in which energy represented, say, one percent of costs. Thus Mr Gilbert noted that the cement industry does "very intensive benchmarking" against competitors in Europe, China, America and Thailand, while Dr Harris said that "energy efficiency has always been a priority for the aluminium industry in order to stay competitive, not only against competitive materials but against the aluminium industries in other parts of the world" (QQ 587, 592).

10.19. The danger, therefore, is that a continuing focus on energy-intensive industries will at best come up against the law of diminishing returns, and at worst may simply drive them out of business or out of the United Kingdom. Many such industries can only reduce energy use to a certain level—cement, for example, is produced by the de-carbonation of limestone, and, as Mr Gilbert explained, a significant proportion of carbon dioxide emissions are an inevitable product of this process, "governed by the rules of thermodynamics and chemistry" (Q 588). Raising the effective price of energy could therefore have dire consequences—described in stark terms by Dr Harris:

> "If there is a view that an increase in energy price leads to a reduction in energy consumption, you have to accept the view that primary aluminium production will inevitably move out of the UK; it will move out of Europe and it will move to those parts of the world where energy is available at a lower cost … I then have to point out that … aluminium will still be used in the UK, but it will be produced in primary smelters in other parts of the world that are less energy-efficient. Effectively, if we are looking at global warming, the position will have got worse." (Q 587)

10.20. The effect of the law of diminishing returns may be compounded for some industries by the cycle of capital investment. The cement industry, for example, has been through a period of major investment in new equipment; this equipment will not be replaced for a considerable time. In other words, for many industries reductions in emissions are not a matter of gradual, year-on-year increments, but of periodic major investment, yielding rapid improvement, followed by periods when emissions stay relatively static.

10.21. This unevenness in the capital cycle may have contributed to specific concerns over the account that has been taken of past improvements in energy efficiency in assigning carbon allocations to particular industries. Mr Richard Boarder, of Castle Cement, and a member of the Emissions Trading Group since its establishment in 1999, confirmed this point: he was "desperately disappointed that early action has not been recognised in that allocation plan", with the result that "our most efficient plant has the lowest allocation" (Q 600). Dr Welsh argued that the allocation did not "take into account several years of programmes to reduce energy consumption in non CCA sites"—in other words, while companies previously involved in CCAs would see "relatively modest" reductions under the EU ETS, businesses not subject to CCAs could be looking for reductions of up to 50 percent (Q 584).

10.22. In marked contrast, large sectors of business have in effect been overlooked. Mr Farrow noted that Government policy "is all focused very much on the manufacturing sector", whereas "they need to think a lot more about what sort of policy tools to use to push energy efficiency issues in the commercial/SME sector". Dr Welsh drew attention to a recent survey, showing that "around half the SMEs were totally unaware of initiatives on the carbon reduction side", some of the SMEs being "relatively energy-intensive". Furthermore, there was an impression that CCAs (which include an 80 percent exemption from the Levy) were something of a closed shop—while in principle "any sector that is prepared to sign up to quite tough energy reductions ought to be able to develop a climate change agreement", in practice the Treasury imposes "a huge amount of red tape", with the result that "a lot of the companies ask whether it is really worth it" (QQ 569, 570, 581, 582).

10.23. We also asked the Carbon Trust, which is tasked with promoting energy efficiency in the business and commercial sectors, about its level of engagement with SMEs—that is companies with up to 250 employees. Mr Delay said that the criterion was energy use; some SMEs, such as small chemical plants, were significant energy users, and would be targeted by the Trust. In contrast, the Trust did not address "those whose energy patterns are typically domestic"—including some 3.5 million SMEs with five employees or less. He described the energy consumption of this sector as "tiny"—less than ten percent of total business energy consumption (QQ 107-109).

10.24. The Action Plan contains no firm proposals on small businesses. Indeed, having noted the difficulty in identifying and targeting such a diverse group, it merely announces that the Government have decided not to extend the EEC to business customers. It continues, "we will … continue to examine, with the Carbon Trust, Energy Saving Trust and others, the scope for ways to realise further energy efficiency improvements in this part of the business sector" (p 43). This amounts to a confession of failure.

10.25. Finally, we have considered the current dispute between the Government and the European Commission over the overall level of the United Kingdom National Allocation Plan (NAP) under the EU ETS. The United Kingdom

NAP was submitted in April 2004, and proposed an allocation of 736.3 $MtCO_2$ (200.8 MtC).[101] This was approved by the Commission on 7 July. However, on 27 October the Government announced that they would seek the Commission's approval to an amendment, increasing the allocation to 756.1 $MtCO_2$ (206.2 MtC). The reason for the change was a change in the projections for "business as usual" emissions, which indicated that the baseline would in fact be higher than expected. The Commission having formally agreed the UK NAP in July, in the process stating that "the total quantity of allowances to be allocated … shall not be exceeded", refused to accept the revised NAP. At the time of writing the Government have agreed to make allocations to individual sectors according to the original NAP, while apparently considering legal proceedings against the Commission over their refusal to accept the revised version.

10.26. This confusion comes at a time when the Government have for the first time conceded that the United Kingdom's targets for reducing carbon emissions are unlikely to be met—a situation that will not be helped by the allocation of an extra 5 MtC to industry. Lord Whitty was robust in dismissing any criticism, noting that the original projections had been out of date, and asking rhetorically, "If the facts change, I change my opinion. What do you do?"—to which the response might be that projections are not facts. All that has happened is that an error in these inherently hypothetical projections has been exposed.

10.27. Opinions differ on the merits of the Government's position. The CBI believed that once the error in the projections had been spotted the Government was "absolutely right" to apply for a revised allocation (Q 583). The Carbon Trust, on the other hand, drew attention to the "lobbying on behalf of the CBI and other industry bodies … at a time when energy prices are increasing significantly", which had made it politically "quite hard" to implement the EU ETS aggressively. Nevertheless, their own analysis, according to Mr Delay, had identified "quite credible scenarios whereby companies will be rather successful at passing on the cost to the consumer and may well end up benefiting from the Emissions Trading Scheme". This would not cover all sectors—aluminium, for instance, would suffer owing to its exposure to international competition (QQ 85, 101).

10.28. In the longer term, Mr Delay identified some potentially graver risks in setting the NAP at too undemanding a level. The worst result would be the complete failure of the ETS—"the carbon price will not be sufficient and it will end up … a white elephant because there is no carbon to be traded" (Q 101). Or, particularly as NAPs across Europe have been "fairly weak", it might not generate enough of an incentive for business "to manage their emissions in a sensible way". This could create long-term unpredictability, as the second phase might have to be "much more aggressive" to compensate. In the absence of a long-term steer through the ETS, "business is not able to sensibly make investment decisions" (Q 96).

[101] See *EU Emissions Trading Scheme: UK National Allocation Plan 2005-2007* (http://www.defra.gov.uk/corporate/consult/euetsnap-stagethree/nap.pdf). The figure of 736.3 $MtCO_2$ represents the total quantity of allowances to be issued to participating installations over the three years of Phase 1 of the scheme (2005-07).

10.29. **Energy-intensive manufacturing industries have contributed a disproportionate share to the reduction in United Kingdom carbon emissions. They continue to be subject to strong international competition, along with rising energy prices and a raft of regulation. There is a serious risk that much of this industry will simply be driven overseas, contributing to a net increase in global emissions. We therefore look to the Government, in the interests both of the economy and the environment, to take full account of the ongoing competitiveness of these sectors within global markets when they consider further climate change targets.**

10.30. **At the same time, there is considerable potential for energy saving by the commercial sector and SMEs, which have so far been overlooked. Reaching SMEs will be a challenging task, but it is one the Government appear to have shied away from. We recommend that the Government urgently explore ways to encourage reductions in energy use by SMEs.**

10.31. **The dispute over the United Kingdom National Allocation Plan has potentially serious consequences. However, while we have sympathy with the views of the CBI, we cannot help concluding that this is a crisis of the Government's making, which adds to the difficulties faced by industry in long-term planning. We urge the Government to seek a rapid resolution to this dispute, even at the expense of some compromise.**

10.32. **We further recommend that the Government re-examine the allocation of carbon allowances to individual industries and companies. It is essential that allowances should be based on real energy efficiency, relative to competitors at home and overseas, whether or not efficiency improvements have been as a result of Climate Change Agreements.**

CHAPTER 11: THE LONGER TERM: RESEARCH

11.1. We have already drawn attention to the Government's long-term goal of putting the United Kingdom on course to reduce emissions by 60 percent from 1990 levels by 2050—a reduction in emissions to around 65 MtC/year, compared with today's CO_2 emissions of around 150 MtC/year. Achievement of this hugely challenging goal will only be possible if there is a well-resourced and well-co-ordinated programme of research and development.

The level and co-ordination of energy research

11.2. It is regrettable that the papers supplied by the Government and Research Councils UK (RCUK), as well as oral and written evidence from other witnesses, fail to provide a clear picture of the United Kingdom research effort. For instance, annual direct Government funding for energy efficiency R&D in 2002-03 is stated to have been just over £10 million, though this was channelled through no fewer than five departments (Defra, DTI, ODPM, the Department for Transport and the Department for Education and Skills), as well as agencies such as the Carbon Trust, Energy Saving Trust and Environment Agency (p 26). However, this figure conflicts with IEA data, according to which United Kingdom spending on energy conservation R&D in both 2002 and 2003 was zero.

11.3. Further funding is channelled through the Research Councils. The "Towards a Sustainable Economy" programme was assigned £28 million in the 2002 Spending Review, of which around £15 million will be used to fund the United Kingdom Energy Research Centre (UKERC) over five years from April 2004. The Tyndall Centre for Climate Change Research is another major joint Research Council project, with funding of £10 million over five years. The Engineering and Physical Sciences Research Council (EPSRC) jointly funds, along with the Carbon Trust, the "Carbon Vision" programme of research into low carbon innovation, to the tune of £14 million. Further funding streams are provided independently by the EPSRC, the Economic and Social Research Council (ESRC) and Natural Environment Research Council (NERC). Overall, we can only echo the conclusion of the Council for Science and Technology, that:

> Funding of renewable and low-carbon energy initiatives in the UK is too fragmented. We recommend that there be institutional changes aimed at coordinating research funding, achieving greater leverage from participation in international programmes and evaluating the outcomes of government investment in the energy sector.[102]

11.4. In the course of our inquiry, a significant increase in funding was announced as part of the 2005 Budget statement:

> "Funding for energy R&D from the Science Budget will rise from a current level of £40 million per year to £70 million per year by 2007-08, with additional support for business via the DTI Technology Programme and The Carbon Trust. To underpin this investment, the Government will establish a UK Energy Research Partnership, bringing together public and private

102 Council for Science and Technology, *An Electricity Supply Strategy for the UK*, May 2005, Executive Summary.

funders of energy research to enhance opportunities for collaboration and identify shared priorities for research."[103]

11.5. This increase in funding for energy research is welcome—indeed, in our Report *Renewable Energy: Practicalities* we recommended that the Government review the level of spending on energy research.[104] However, the money already available is funding a wide range of programmes, networks, consortia—and while major initiatives such as the UKERC stand out, it is by no means easy to detect an overall pattern. The Royal Academy of Engineering argued that compared with the United States the United Kingdom funding structure for research was "complicated and horizontally stratified", to the extent that "total Energy R&D spend was not collected centrally in any of the recent UK Government energy reviews"—a point confirmed by the difficulty we have experienced in putting together a coherent picture of research spending. The result, according to the Academy, is that innovative ideas have to work their way up through the different funding source layers, "re-competing for resources at each stage" (p 327).

11.6. The perception that energy research is unco-ordinated is not a new one—as far back as 2001 Sir David King's Energy Research Review Group recommended the establishment of the UKERC with a view to providing a better focus for research.[105] The Academy recommended that a "high priority" for the UKERC should be the preparation of a clear "roadmap for research". We are therefore pleased to note, both from RCUK's written evidence and from our discussion with Professor Jim Skea, Research Director of the UKERC, that the development of a single "research portal" and "road mapping" of energy research are among its first projects. As Professor Skea noted, such preparatory work is essential if we are to "try to identify future research priorities and the sequence of research problems which need to be solved if you are going to get to certain points in the future in the energy system" (Q 247).

11.7. However, we are unclear what value the "UK Energy Research Partnership", which was announced in the Budget statement, will bring to the research effort. The proposal seems to have emerged from the blue—none of the evidence we received (which was prepared in the second half of 2004) mentions it. On the contrary, our evidence demonstrates that there are already abundant networks, consortia, partnerships, and so on, as well as the UKERC itself, all seeking to bring together the various funding agencies, researchers, and private companies.

11.8. In contrast, while we were impressed by the way Professor Skea and his colleagues are going about their work, they are hampered by the nebulous quality of the UKERC itself. Professor Skea, with some understatement, noted that "given the history of energy research in the UK over the last ten to fifteen years or so, the competences that we have are rather distributed geographically". Partly as a result of this, the Centre has no physical presence—it is a "virtual" or "distributed" centre, a term Professor Skea admitted was "almost an oxymoron". Nor does the Centre have a legal personality, with the result that it cannot itself apply for European funds—it

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103 *Budget 2005* (16 March 2005, HC 372), p 65.

104 *Renewable Energy: Practicalities*, pp 29-30.

105 Chief Scientific Adviser's Energy Research Review Group (http://www.ost.gov.uk/policy/issues/csa_errg/main_rep.pdf).

simply seeks to facilitate and co-ordinate the work of partner organisations, acting as a "kind of marriage broker". When it was put to him that the Centre, while better than nothing, was not as good as it might be, Professor Skea admitted that this was "a fair way of putting it" (QQ 235, 239, 236).

11.9. **In 2001 Sir David King recommended the establishment of the UKERC. The Centre is now in existence, but its staff are handicapped by the half-hearted way in which it has been established. A "distributed centre", dependent on Research Council support, cannot provide leadership for the many, widely dispersed energy research projects around the country. We therefore recommend that the Government, in addition to the forthcoming review of the first phase of the UKERC's work by the Research Councils, separately consider ways to strengthen the Centre, giving it greater autonomy, a physical presence and legal personality. Additional investment in the UKERC would in the longer term be money well spent.**

11.10. **We are mystified by the announcement that the Government intend to establish a "UK Energy Research Partnership". We already have the UKERC, Research Councils, the Carbon Trust, and Regional Development Agencies. We believe that it would be more fruitful to strengthen the role of the UKERC, and that no case has yet been made for adding another layer of bureaucracy to the administration of energy research. We therefore look to the Government to explain the benefits of this proposal in greater detail.**

11.11. Even the extra funding announced in the Budget represents a modest increase from a very low base. Funding fell dramatically after the privatisation of the energy industries in the 1980s—the Council for Science and Technology note that by 2003 it had fallen to around five percent of the 1974 level.[106] IEA data show that by 2001 (the last year for which complete figures are available) United Kingdom spending on energy research, at just over £30 million, was little more than half that of Sweden, and about a tenth that of France. In contrast, spending in both Japan and the United States was of the order of US$3 billion. As a percentage of GDP, United Kingdom spending on energy R&D, which included no spending at all on energy conservation research according to IEA figures, was markedly lower than that in any of its major competitors, as is illustrated in Table 2. In the same year Sir David King's Review recommended that "Spending, over time, should be brought more in line with that of our nearest industrial competitors in Europe".

11.12. Providing additional funding will only yield results if there is a strong research base in place. Professor Skea summed up the current position: "I do not think we have the capacity to double or triple our research funding in this area overnight and for there to be sufficient people there to carry it, but if there is a gradual increase in funding I think there are ways of … [improving] the effectiveness of our research". In particular, new researchers could be attracted from parallel fields, for example in materials research, while established skills could be brought from overseas. At the same time, Professor Skea emphasised the importance of "beginning to develop the courses" and getting post-graduates to start up in the field (Q 267).

[106] Council for Science and Technology, *op. cit.*, Annex A3.

TABLE 2

Energy R&D spending in selected countries in 2001[107]

	2001 total R&D expenditure (US$ millions)	*2001 total R&D expenditure (% GDP)*
Canada	189.4	0.026
Denmark	39.4	0.025
France	395.3	0.030
Germany	261.9	0.014
Italy	253.4	0.031
Japan	3,568.0	0.086
Netherlands	142.6	0.037
Sweden	73.8	0.034
United Kingdom	43.7	0.003
United States	2,905.2	0.029

11.13. **We welcome the increase in funding for energy research and development, from £40 million to £70 million by 2007-08, which was announced in the 2005 Budget statement. However, we note that funding for energy research in the United Kingdom will still be at a very low level compared to international competitors, particularly where research into energy conservation is concerned. Funding must rise much further if the Government's ambitious energy policy objectives are to be achieved.**

11.14. **We therefore recommend that the Government signal their long-term commitment to a progressive increase in funding for energy research to at least average IEA levels as a proportion of GDP by 2020. We believe such a commitment is essential in order to encourage new researchers to enter the field, and to stimulate the development of the energy research base at all levels.**

Research priorities

11.15. The Government identified two kinds of research that would be necessary in the longer term: first, "incremental R&D", designed "to reduce the capital cost and transaction costs associated with existing energy efficiency technologies, and accelerate existing technologies". Such incremental R&D—which in reality will be as much a matter of development and demonstration as of original research—should have timelines of "3-5 years". Secondly, there will have to be "step change R&D", bringing forward "pioneering technologies which have potentially a major impact in the long term". Such research would have a lead time of "10-20 years", and examples cited by the Government included "integrated process control systems for low carbon buildings and new low carbon products"—related to both power generation and use (p 26).

107 Source: IEA. Totals for both GDP and R&D expenditure have been converted into US dollars using 2001 exchange rates. The strength of the dollar in 2001 means that the absolute figures for R&D expenditure for countries other than the United States are artificially depressed.

11.16. It is not the purpose of this report to speculate on possible "step-change technologies", though we are conscious that there are research programmes which look at such timescales. As RCUK pointed out, one of the major Carbon Vision projects is a £5.4 million "Buildings for Low Carbon Communities" consortium, which began in October 2004, and is intended to demonstrate how emissions from buildings can be reduced by 50 percent by 2030. Looking still further ahead, the Tyndall Centre sponsors research, co-ordinated by the Environmental Change Institute in Oxford, under the heading "the 40 percent house", which seeks to identify ways in which the RCEP recommendation of a 60 percent reduction in emissions by 2050 could be achieved in the domestic sector.

11.17. Yet while researchers consider long-term strategies for achieving radical reductions in emissions from buildings, which make up half of emissions, the "incremental" phase of research—testing materials, insulation, construction techniques, and building up links with the construction industry, so that from development and demonstration such technologies can move to general commercial deployment—appears to be neglected. Dr Wyatt, Chief Executive of the Building Research Establishment, provided a devastating summary of the current position: "We are now really the only country in Europe—with 21 equivalents across Europe—and there are equivalents in Canada, Australia, New Zealand or wherever—we are the only country in the world where there is no co-ordination of … applied research … working with the construction industry to the industry." (Q 02)

11.18. Dr Wyatt's description of how this situation has arisen was a damning indictment of the lack of joined-up Government. After the 2001 general election responsibility for funding construction research was moved from the Department for Transport, Local Government and Regions to the DTI, on the basis that "construction was an industry like any other industry". Since then the DTI has rationalised its sponsorship of research, bringing it under a single Technology Programme, which, as Dr Wyatt put it, is more concerned with "break-through science" rather than applied science. The result is that the BRE, as the largest centre of applied construction research, is "simply told we are as welcome as the aerospace industry to bid in to the nano-technology programme, and if that is unsuitable, that is hard luck". The result is that Government funding has been withdrawn from around 85 percent of relevant research projects.

11.19. By means of Questions for Written Answer we have elicited figures for Government funding for applied construction research, which bear out Dr Wyatt's claim of a dramatic fall in funding following the move to the DTI in 2001, and in particular following the termination in March 2002 of the BRE Framework Agreement that eased the BRE's transition into the private sector. The figures given are in Table 3.

TABLE 3

United Kingdom Government funding for applied construction research[108]

	£ millions
1997–98	17.5
1998–99	16.2
1999–00	17.0
2000–01	18.1
2001–02	16.2
2002–03	14.8
2003–04	10.0
2004-05	5.5

11.20. These are shocking statistics. And as Dr Wyatt pointed out, this has happened with "no policy decision, no policy announcement, and no consultation with the industry. All that has happened is that the portfolio has moved from one department to another, and 85 percent of it fell down the crack in the process." (Q 502)

11.21. The fall in government funding would not be so damaging if the private sector were in a position to make up the shortfall. Unfortunately it is not. The fragmentation of the construction industry, with 350,000 businesses employing around three million people, means that, in the words of a report by the former Chief Scientific Adviser Sir John Fairclough commissioned by DTLR in 2001, the vast majority of businesses "cannot be expected to engage with a strategic research agenda".[109]

11.22. Sir John's conclusion even in 2001-02 was that "public investment in construction research seems to be inadequate when compared to the size and importance of the sector and its contribution to the UK's economic, social and environmental wellbeing". He noted that the public sector spent (at that time) some £25 billion per annum on procurement from the industry, and commented that "a relatively small upfront investment in well targeted research should yield very substantial benefit to the public purse". He recommended that available resources for construction R&D were "the minimum that the sector deserves", and called on the Government, as "guardian of the public interest and major client", to "facilitate longer term strategic thinking" about the framework for construction R&D.[110]

11.23. None of this appears to have happened. Not only has research funding been drastically cut, but nothing appears to have been done regarding the development of a long-term, strategic vision of the priorities for construction research. In answer to a Question for Written Answer, the Science Minister Lord Sainsbury of Turville stated that following the Fairclough report "the Government challenged the Strategic Forum for Construction and nCRISP, the new Construction Research and Innovation Strategy Panel, to develop and own the strategic vision for the sector … There has been some progress

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108 Source: Written answers (HL Deb., 21 February 2005, WA 178, and 23 March 2005, WA 60). The figure for 2004-05 is based on current commitments at the time the answer was issued (23 March). As this was little over a week from the end of the financial year the figure is likely to be fairly accurate. At that stage commitments for 2005-06 were just £3 million.

109 *Rethinking Construction Innovation and Research: A Review of Government R&D Policies and Practices*, by Sir John Fairclough, 2002, p 11.

110 Ibid., pp 28-29.

towards this goal but more needs to be done".[111] This looks very much like confirmation of Dr Wyatt's claim that the Fairclough report had been "kicked into the long grass" (Q 502).

11.24. Pressed on what the Government had done to implement Sir John's recommendation that they reconsider their level of investment in construction R&D, a further written answer largely confirmed Dr Wyatt's description, drawing attention to the fact that the DTI had now developed "a number of generic support products within the technology strategy, no longer linked to individual sectors such as construction". The Government also argue that "the onus is … on the sector itself to take advantage of funding opportunities as they arise"[112]. This approach appears to ignore the peculiarities of the construction industry that make co-ordinated, strategic action so difficult. Moreover, the Chancellor's announcement of new funding for energy research made it clear that the money would in part be channelled through the existing DTI Technology Programme, holding out little prospect that the new money will go where it is so urgently needed. In short, the DTI appear to have washed their hands of the matter. In such circumstances there is a strong case for making separate provision for construction research, and assigning responsibility to the ODPM, which has responsibility for planning, building standards and the delivery of affordable, sustainable housing.

11.25. **We were shocked by the decline in DTI funding for applied construction research since 2002. While drawing attention to the importance of incremental research, the Government have withdrawn funding for just such research in a sector that is both central to future energy efficiency improvements, and in which they invest over £30 billion in procurement annually. We therefore recommend that the Government urgently commission a follow-up to Sir John Fairclough's 2002 report on construction research, with a view to identifying ways to rectify the situation, and in particular that they transfer responsibility for construction research from the DTI to ODPM.**

[111] HL Deb., 27 January 2005, WA 183.

[112] HL Deb., 23 February 2005, WA 209.

CHAPTER 12: CONCLUSIONS AND RECOMMENDATIONS

12.1. Below is a summary of our conclusions and recommendations. References to the paragraphs of the report where these paragraphs can be found in context are given in brackets.

Definitions and measures

Background

12.2. Energy efficiency has been drafted into the service of a wide range of policy objectives since the 1970s, but the way it has been understood and measured has been elusive and variable. We have been dismayed in the course of our inquiry by the inconsistency and muddle of much current thinking about energy efficiency. (Paragraph 2.7)

12.3. This muddle is not the sole responsibility of Government, but only Government can resolve it. However, the current attempt to present energy efficiency as "the most cost-effective way to meet all [four] energy policy goals" only adds to the confusion. At the very least, careful oversight will be needed to ensure that the targets set for energy efficiency are defined, that conflict between them is avoided, and that progress is measured. We urge the Government to bring greater clarity and intellectual rigour to its presentation of energy efficiency. (Paragraph 2.8)

Measuring energy efficiency

12.4. In September 2004 the Prime Minister identified climate change as "the world's greatest environmental challenge". We agree, and believe that the fundamental objective of policies in favour of energy efficiency at the present time must be the absolute reduction of carbon emissions. This objective must be reflected in the setting of targets for and the measurement of energy efficiency. While the targets in the White Paper have been expressed in terms of reductions in carbon equivalent emissions, the confusion of measures that is found elsewhere in Government policy statements undermines their credibility. We recommend that the Government henceforth adopt a more rigorous approach to the measurement of energy efficiency in terms of carbon. (Paragraph 2.17)

Establishing a baseline

12.5. Levels of carbon emissions should be grounded in clear historical data, not hypothetical projections. Insofar as projections are necessary, the methodology on which they are based should be explicit, transparent and consistent. None of these requirements is being met at present. The "baseline" for the White Paper targets, which is derived from the projections contained in the 2001 Climate Change Programme (which itself took into account the impact of policies introduced by the Government after the signing of the Kyoto Protocol in 1990) is obscure. We recommend that the Government ground its targets more firmly in reality, making it clear how they are derived and expressing them in absolute year-on-year carbon equivalent emissions. (Paragraph 2.30)

Energy efficiency and carbon

12.6. In order to be able to measure the contribution of energy efficiency to emissions targets, the Government should develop and publicise an explicit and transparent methodology for calculating the relationship between use of delivered energy and greenhouse gas emissions. We have commissioned research which provides one such methodology, which we believe provides the basis for developing a reliable tool for measuring the contribution of energy efficiency to reductions in greenhouse gas emissions. We draw it to the attention of Government. (Paragraph 2.43)

The fuel mix

12.7. We welcome that fact that the United Kingdom remains on track to meet its Kyoto obligations. However, as the emissions data for 2003 show, there is no cause for complacency or self-congratulation—the Government have themselves conceded that the domestic targets contained in the Energy White Paper are unlikely now to be met. In fact the United Kingdom had already met its Kyoto obligations before the end of the 1990s, largely for structural reasons and because of changes in the fuel mix, whereas since 1999 carbon dioxide emissions have risen. (Paragraph 2.49)

12.8. Energy efficiency could contribute significantly to future reductions in emissions, and in the remainder of this report we analyse ways in which this contribution can be maximised. However, we believe that in the long term there is no prospect of the Government's climate change objectives being met unless there are also innovations in generating technology, fundamentally changing the carbon intensity of the primary fuel mix. We urge the Government to face up to this issue. (Paragraph 2.50)

The economics of energy efficiency

Energy efficiency and energy demand

12.9. The Government's proposition that improvements in energy efficiency can lead to significant reductions in energy demand and hence in greenhouse gas emissions remains the subject of debate among economists. The "Khazzoom-Brookes postulate", while not proven, offers at least a plausible explanation of why in recent years improvements in "energy intensity" at the macroeconomic level have stubbornly refused to be translated into reductions in overall energy demand. The Government have so far failed to engage with this fundamental issue, appearing to rely instead on an analogy between micro- and macroeconomic effects. (Paragraph 3.11)

12.10. We welcome the UKERC project to investigate the "rebound effect" and the empirical basis for the "Khazzoom-Brookes postulate", and recommend that the Government, in parallel with the establishment of a more robust measure for energy efficiency, take full account of the project's progress and results in developing future policies in this area. (Paragraph 3.12)

Cost effectiveness

12.11. We recommend that the Government exercise caution in using the potentially misleading term "cost-effective" to describe investment in energy efficiency. They should seek to demonstrate realism as to what is economically achievable by means of private sector investment in energy efficiency. (Paragraph 3.18)

12.12. We further recommend that the Government promote the application of the Green Book guidelines, encouraging decision-makers at all levels, including local authorities, housing associations, PFI projects and other private sector providers to the public sector, to consider lifetime costs in committing expenditure to long-term capital projects. (Paragraph 3.19)

Policy coherence and departmental structure

Central government

12.13. The Government assert that the Strategic Energy Policy Network (SEPN) ensures effective co-ordination across Departments and agencies. The evidence we have heard does not bear this out. While there will inevitably be boundaries between different departmental responsibilities, the way these are currently set is a recipe for confusion. We therefore recommend once again that the Government bring together responsibility for those aspects of energy policy currently handled by Defra and the DTI under a single Energy Minister. We believe this to be a necessary first step if the wide range of policies and agencies in the energy field are to be rationalised and effectively co-ordinated. (Paragraph 4.15)

12.14. We believe that the existence of two agencies promoting energy efficiency risks overlap and confusion. We therefore recommend that the Carbon Trust and the Energy Saving Trust be merged. (Paragraph 4.16)

Local government

12.15. Local authorities are in many cases better placed than central Government to bring together local people and industry in developing innovative projects to promote sustainability and energy efficiency. However, there is no consistency of approach across local authorities, while the successes of authorities such as Leicester and Woking appear to have been if anything hindered rather than helped by central Government. We therefore recommend that the Government both make more effort to disseminate the existing "invest to save" rules, and explore new ways to promote dynamic local action in pursuit of its energy policy goals. In particular the Government should consider the model of the Swedish Local Investment Programme, as a highly effective means to kick-start local initiatives. (Paragraph 4.23)

The European Union

12.16. The European Union is already influential in the field of energy efficiency, and is likely to become still more influential in future. We look to the Government to ensure that the United Kingdom uses the opportunity presented by its forthcoming Presidency to promote best practice, negotiating effective, enforceable legislation where appropriate, and at the same time ensuring that the principles of subsidiarity and proportionality are respected. (Paragraph 4.26)

Behaviour

Incentives

12.17. We endorse the view of the Energy Saving Trust, that the Government should urgently review the fiscal incentives to energy efficiency. None of the proposals we have heard appears to be without difficulties, but we look forward to the results of the pilot scheme initiated by British Gas and Braintree Council, which should provide valuable information on the effectiveness of Council Tax rebates. (Paragraph 5.29)

12.18. We look forward to the results of the Carbon Trust's review of the impact of the Enhanced Capital Allowances scheme, and, subject to the results of that review, recommend strengthening the financial incentives for small companies, and increasing use by the public sector of the Energy Technology List. This should include the extension of the requirement to use the List to Private Finance Initiative projects. (Paragraph 5.30)

12.19. We welcome the current energy services pilot scheme. If the results of the pilot are satisfactory we look forward to the extension of the energy services model nationally. (Paragraph 5.31)

12.20. We further recommend that the Government and regulator review current energy pricing arrangements, which create a perverse incentive to consume more energy. In particular, we recommend that the Government explore the feasibility of introducing pricing arrangements based on the model of "lifeline tariffs". (Paragraph 5.32)

Education

12.21. We recommend that the Government make ear-marked funding available, possibly as part of the "Building Schools for the Future" programme, to finance innovative, energy-based school projects such as those in Leicester. (Paragraph 5.33)

12.22. There are currently too many possible sources for energy efficiency advice; the quality is inconsistent, and follow-up patchy. We welcome the efforts of the Energy Saving Trust and Energy Advice Providers Group to bring coherence to the field. (Paragraph 5.41)

12.23. However, we believe that local authorities, particularly if they are able to assume the more proactive role in promoting energy efficiency that we have already recommended, are likely to be best placed to provide impartial advice tailored to the needs of local consumers. We recommend that the new Sustainable Energy Network be developed in such a way as to promote best practice, while ensuring that the responsibility for delivering advice is devolved to local level. (Paragraph 5.42)

12.24. Wherever possible energy efficiency advice should be tied to firm data so as to produce specific recommendations for action. Energy supply companies are to an extent already offering such a service by means of energy surveys. The introduction of Energy Performance Certificates will offer an ideal opportunity for local authorities to target advice more effectively. (Paragraph 5.43)

Information

12.25. We recommend that the Government, together with the regulator, not only press forward their review of the presentation of information on bills, but that they specifically explore innovative ways in which information can be presented so as to exert the greatest possible influence on behaviour. (Paragraph 5.46)

12.26. Since 2001 the Government has dragged its feet on smart and remote metering, and now appears to be resisting draft European legislation that would require more rapid development of the technology. We deplore this. In the long term, the surest way to achieve lasting reductions in energy use is to empower consumers—to provide them with the information that enables them to manage their energy use. We therefore urge the Government to take the lead in establishing a large-scale trial both of remote metering and of low-cost options for “smart” domestic display units, which could be rapidly developed and rolled out. (Paragraph 5.57)

New Buildings

Building regulations

12.27. It is disappointing that the standards of energy efficiency required by Part L of Building Regulations will, even after the latest review, not match the best standards in Europe. We have considerable sympathy with those who argue for a step-change in these standards. However it appears on balance that the construction industry in this country is not equipped, particularly in terms of skills, to cope with such a step change. The Government’s approach of regular reviews between now and 2020 therefore represents a pragmatic approach. However, it is essential that the Government set a clear direction for the next 15 years, and demonstrate its determination not to let a conservative industry hold back progress. (Paragraph 6.14)

The code for sustainable buildings

12.28. We strongly believe that the new Code for Sustainable Buildings should build upon the existing BREEAM and EcoHomes standards. There is no need to reinvent the wheel. BREEAM and EcoHomes are well-established, and have been developed with the full input of the construction industry as well as the research expertise of the BRE. We doubt that any new Code would have similar authority or would command similar support. (Paragraph 6.20)

12.29. We note that ODPM, as part of its consultation on the revision of Part L, has published papers setting out aspirational standards for 2010. We welcome this initiative, and recommend that aspirational standards in future be built into the Code for Sustainable Buildings, so as to give a clear signal to the industry of future trends in Building Regulations. (Paragraph 6.22)

Enforcement

12.30. We share the alarm of the Environmental Audit Committee at the “apparent ease and possible extent of non-compliance with Part L of Building Regulations”, and endorse their recommendation that ODPM conduct a thorough review of the problem. (Paragraph 6.29)

12.31. We are concerned that the introduction of competition and self-certification into the building control process has already led to falling standards, and will continue to undermine efforts to raise standards. We urge the Government to ensure that adequate quality assurance, through a system of formal accreditation, is in place to underpin the process. (Paragraph 6.30)

12.32. We further recommend that the Government increase the resources available to local authority Building Control sections in order to assist them both in on-site inspection and in bringing prosecutions for non-compliance. (Paragraph 6.31)

12.33. With increased design flexibility, and in the absence of clear, mandatory pass/fail tests, or specific requirements for components such as double glazing, the task of monitoring and enforcing compliance with Building Regulations has become almost impossible. We recommend that the Government introduce a series of mandatory tests for completed buildings. In particular, we look to ODPM to abide by its stated intention to introduce mandatory pressure-testing for all new buildings. (Paragraph 6.32)

Construction: skills and training

12.34. Skills shortages pose a serious threat to the Government's energy efficiency targets, particularly given the major house-building programme now under way. It is essential that the Government address these issues in a more energetic and co-ordinated fashion than they have done hitherto. (Paragraph 6.39)

12.35. Skills shortages are compounded by a widespread culture of sloppy workmanship and cost-cutting by builders. This must change, and in tandem with improved enforcement of building standards we recommend that the Government strengthen the legal rights of purchasers who acquire poorly built properties. (Paragraph 6.40)

Energy Performance of Buildings Directive

12.36. The Government appear to have done little to prepare for implementation of the Energy Performance of Buildings Directive. We fear, for instance, that the Government's failure to train adequate numbers of inspectors will be used as an excuse for deferring full implementation, or for adopting a narrow, "lowest common denominator" interpretation of the term "public buildings". We deplore this prospect, and urge the Government both to adopt a broad definition of "public buildings", and to make preparation for the Directive a high priority between now and January 2006. (Paragraph 6.45)

12.37. Energy Performance Certificates could potentially be as influential in improving building standards and advancing the Government's energy efficiency objectives as "Investors in People" accreditation has been in promoting good management practices. We therefore urge the Government to give careful thought to the design and display of certificates. (Paragraph 6.46)

The scope for improving building standards

12.38. The scope for improving the energy efficiency of new buildings in the United Kingdom is clear. However, although there have been individually impressive projects such as the BedZED development in Sutton, many more such projects will be needed before it is clear what approach yields the best results. Indeed, the best approach may differ between the north and south of the country. (Paragraph 6.55)

12.39. Modern Methods of Construction have proved to be a cost-effective way to achieve high levels of build quality and energy efficiency in many parts of the world, particularly in colder climates, and we support the Government's aim to introduce them more widely in this country. However, in certain circumstances, particularly in larger commercial or office buildings, or possibly in warmer parts of the country, the cooling effects of high thermal mass may yield better results in terms of overall energy use. We urge the Government, particularly in its role as a major procurer of new building, to show leadership in promoting innovation on the part of a largely conservative industry. (Paragraph 6.56)

Existing buildings

Energy efficiency commitment

12.40. We urge the Government to consider further fiscal incentives to encourage private and social sector landlords to invest in energy efficiency. We welcome the announcement in the 2004 Budget that the Government would give consideration to a "green landlords" scheme, and look forward to further progress on this proposal. (Paragraph 7.19)

12.41. We are concerned that the methodology for calculating the carbon benefits of the Energy Efficiency Commitment is so lax, and so poorly supported by hard data. While we support the data monitoring being undertaken by the Energy Saving Trust, we also recommend that the Government take steps to oblige energy supply companies to collect specific but anonymised data on energy use and make them available to the research community. (Paragraph 7.22)

12.42. There is a risk that solid-walled houses, the least energy efficient, will not benefit from the Energy Efficiency Commitment. The development of cheaper and less intrusive insulation for such properties is a key priority for future research. (Paragraph 7.24)

Heritage

12.43. We recommend that the Government review the guidance issued to planning authorities with a view to developing a more flexible approach to energy efficient refurbishment of older buildings. (Paragraph 7.27)

Demolition and refurbishment

12.44. We recommend that the Government review its strategy on demolition of poor quality housing. (Paragraph 7.29)

12.45. We welcome the Government's commitment to arguing within the Council of Ministers for further revision of VAT rules in order to stimulate energy efficiency. However, the changes that have been agreed so far, such as the reduction of VAT on micro-CHP, are relatively peripheral. Far more important is the perverse effect of the current application of the full rate of VAT to building extension and refurbishment. We recommend that the Government redouble its efforts to persuade the European Union of the need to give strong fiscal signals to encourage energy efficient refurbishment of existing buildings. (Paragraph 7.36)

12.46. We welcome the consideration that the Government have been giving to extending Building Regulations to cover existing buildings. However, in order to avoid creating a disincentive to building improvement, we recommend that the cost to property-owners of any extension of regulation in this area be offset by financial incentives such as a reduction in VAT. (Paragraph 7.37)

The public sector

12.47. We welcome the Government's targets for sustainable development in the Government estate, in particular the announcement that they will procure only buildings in the top quartile of energy performance for the central Government estate. We agree with the Government in believing that this will have a marked effect on the wider commercial property market. (Paragraph 7.42)

12.48. However, uncertainties remain over the coverage of these targets: for example, the target for central Government energy use contained in the Action Plan is not in itself adequate, given the huge size and the diversity of the public estate. We therefore look to the Government to extend their initiatives on procurement and energy use to all parts of the public estate as soon as possible. (Paragraph 7.43)

The Parliamentary Estate

12.49. We commend the authorities of both Houses for their achievements in controlling energy use within the Parliamentary Estate. However, we believe that Parliament should seek to set an example for the wider public sector. We therefore make the following recommendations to the House authorities:

- That the House of Lords Corporate Business Plan include specific targets for reducing energy use and greenhouse gas emissions, and that Office Business Plans incorporate specific initiatives to deliver these targets;
- That Black Rod's Office, together with the Serjeant's Department in the House of Commons, explore the feasibility of acquiring for Parliament an information system that would collect and monitor energy data, so as to facilitate real-time management of energy use;
- That regular reports on trends in energy consumption be presented to the appropriate domestic committees of both Houses;
- That, in accordance with best practice guidance, a full-time Energy Manager be appointed, and that his role be strengthened in order to reflect the higher prominence of energy within the House of Lords Corporate Business Plan;
- That the Energy Manager be tasked with strengthening the existing energy strategy, with a view to meeting the agreed targets;
- That domestic committees be invited to endorse the strategy and to establish clear guidance for both staff and Members on energy use;

- That ambitious energy efficiency targets be incorporated into the project to prepare the Millbank island site for occupation by the House of Lords. (Paragraph 7.52)

Developing markets for heat

12.50. We recommend that ODPM encourage local authorities and developers to incorporate community heating as standard in all new build projects. (Paragraph 8.9)

Barriers and policy measures

12.51. We endorse the recommendation of the IPA study that the Community Energy Programme be extended. However, we note that the programme has had limited impact so far, and that commercial barriers to the take-up of heat provision must also be addressed. (Paragraph 8.14)

12.52. It is time for the Government to progress from analysis to action in promoting markets for heat, particularly from renewable sources, and we so recommend. (Paragraph 8.18)

12.53. We recommend that the Government explore the application of the Energy Services model to community heating. In particular, we believe that the establishment of the London Climate Change Agency offers a unique opportunity to apply such a model on a large scale, with corresponding gains in energy efficiency and emissions. (Paragraph 8.22)

Appliances

European Union product standards

12.54. Product labelling, to be effective, must be dynamic, reflecting technological innovation and product improvement. The EU energy labelling scheme, for all its past success, is in danger of becoming outdated and inflexible. The decision to introduce "A+" and "A++" ratings fundamentally undermines the scheme's integrity, while European product standards lag behind those in the far East and North America. (Paragraph 9.12)

12.55. We therefore urge the Government to use their forthcoming EU Presidency to engage with the European institutions and Member States in strengthening and extending the mandatory labelling scheme. This process should include an investigation into whether the EU Commission has sufficient resources to implement and update the scheme adequately. It should also include consideration of comparable schemes elsewhere in the world, such as the Japanese "top runner" scheme, and their applicability within the EU. (Paragraph 9.13)

12.56. We welcome the Government's commitment to securing agreement to the EcoDesign of Energy Using Products Directive, and look forward to progress in this area. We recommend that the provisions of the Directive be used to establish challenging minimum standards for a wider range of energy using products. (Paragraph 9.14)

12.57. We also urge the Government to argue the case for extending the existing, standardised labelling scheme to a wider range of products, including IT equipment and televisions. (Paragraph 9.15)

Market transformation

12.58. The Market Transformation Programme is too reactive, too nebulous in organisation and working methods, and too unfocused in its objectives and measures of success. We therefore recommend that the Government review the effectiveness of the MTP, with a view to giving more dynamic and effective leadership to the process of market transformation. (Paragraph 9.21)

Risk areas

12.59. The fast-growing, diverse market for consumer electronics presents a serious a risk of uncontrollable rises in energy consumption. The Government's reliance on voluntary codes and best practice guidelines, while it may deliver improvements in certain areas, is a piecemeal and fundamentally inadequate response to this threat. We therefore recommend that the Government examine the feasibility of setting minimum standards for this sector, as well as requiring better information for consumers, for example on standby power consumption. (Paragraph 9.28)

12.60. The projected trebling over the next 20 years of the floor area in commercial or office buildings that is air conditioned has serious implications for future energy consumption. We welcome the willingness of the air conditioning industry to engage in discussion on minimum efficiency standards and the development of Building Regulations, and recommend that the Government address these issues as a matter of urgency. (Paragraph 9.31)

Industrial energy efficiency

Climate change instruments affecting industry

12.61. We agree with our witnesses that the multiplication of schemes to promote industrial energy efficiency has been poorly planned, and is likely to be burdensome and bureaucratic. We urge the Government to make a long-term commitment to consolidating these various schemes under the EU Emissions Trading Scheme, which is likely to be the most cost-effective route to emissions reductions. (Paragraph 10.16)

12.62. We view the Government's apparent support for "white certificate" trading with serious concern: the introduction of yet another set of trading arrangements, incorporating yet another measure (in this case, targets for energy efficiency) is a recipe for still more confusion. What is needed is a period of policy consolidation and clarification, not the over-layering of existing policies with new targets and incentives. (Paragraph 10.17)

12.63. Energy-intensive manufacturing industries have contributed a disproportionate share to the reduction in United Kingdom carbon emissions. They continue to be subject to strong international competition, along with rising energy prices and a raft of regulation. There is a serious risk that much of this industry will simply be driven overseas, contributing to a net increase in global emissions. We therefore look to the Government, in the interests both of the economy and the environment, to take full account of the ongoing competitiveness of these sectors within global markets when they consider further climate change targets. (Paragraph 10.29)

12.64. At the same time, there is considerable potential for energy saving by the commercial sector and SMEs, which have so far been overlooked. Reaching SMEs will be a challenging task, but it is one the Government appear to have shied away from. We recommend that the Government urgently explore ways to encourage reductions in energy use by SMEs. (Paragraph 10.30)

12.65. The dispute over the United Kingdom National Allocation Plan has potentially serious consequences. However, while we have sympathy with the views of the CBI, we cannot help concluding that this is a crisis of the Government's making, which adds to the difficulties faced by industry in long-term planning. We urge the Government to seek a rapid resolution to this dispute, even at the expense of some compromise. (Paragraph 10.31)

12.66. We further recommend that the Government re-examine the allocation of carbon allowances to individual industries and companies. It is essential that allowances should be based on real energy efficiency, relative to competitors at home and overseas, whether or not efficiency improvements have been as a result of Climate Change Agreements. (Paragraph 10.32)

The longer term: research

The level and co-ordination of energy research

12.67. In 2001 Sir David King recommended the establishment of the UKERC. The Centre is now in existence, but its staff are handicapped by the half-hearted way in which it has been established. A "distributed centre", dependent on Research Council support, cannot provide leadership for the many, widely dispersed energy research projects around the country. We therefore recommend that the Government, in addition to the forthcoming review of the first phase of the UKERC's work by the Research Councils, separately consider ways to strengthen the Centre, giving it greater autonomy, a physical presence and legal personality. Additional investment in the UKERC would in the longer term be money well spent. (Paragraph 11.9)

12.68. We are mystified by the announcement that the Government intend to establish a "UK Energy Research Partnership". We already have the UKERC, Research Councils, the Carbon Trust, Regional Development Agencies. We believe that it would be more fruitful to strengthen the role of the UKERC, and that no case has yet been made for adding another layer of bureaucracy to the administration of energy research. We therefore look to the Government to explain the benefits of this proposal in greater detail. (Paragraph 11.10)

12.69. We welcome the increase in funding for energy research and development, from £40 million to £70 million by 2007-08, which was announced in the 2005 Budget statement. However, we note that funding for energy research in the United Kingdom will still be at a very low level compared to international competitors, particularly where research into energy conservation is concerned. Funding must rise much further if the Government's ambitious energy policy objectives are to be achieved. (Paragraph 11.13)

12.70. We therefore recommend that the Government signal their long-term commitment to a progressive increase in funding for energy research to at least average IEA levels as a proportion of GDP by 2020. We believe such a commitment is essential in order to encourage new researchers to enter the field, and to stimulate the development of the energy research base at all levels. (Paragraph 11.14)

Research priorities

12.71. We were shocked by the decline in DTI funding for applied construction research since 2002. While drawing attention to the importance of incremental research, the Government have withdrawn funding for just such research in a sector that is both central to future energy efficiency improvements, and in which they invest over £30 billion in procurement annually. We therefore recommend that the Government urgently commission a follow-up to Sir John Fairclough's 2002 report on construction research, with a view to identifying ways to rectify the situation, and in particular that they transfer responsibility for construction research from the DTI to ODPM. (Paragraph 11.25)

APPENDIX 1: MEMBERS AND DECLARATIONS OF INTEREST

Members:

	Lord Broers
†	Lord Lewis of Newnham
†	Lord Lindsay
†	Lord Oxburgh
	Lord Patel
	Lord Paul
	Baroness Perry of Southwark (Chairman)
	Baroness Platt of Writtle
	Baroness Sharp of Guildford
*	Lord Taverne
†	Lord Wade of Chorlton
	Lord Winston
	Lord Young of Graffham

†	Co-opted Members
*	Joined the Committee on 4 December 2004

Declared Interests:

Lord Lewis of Newnham

Chairman, Onyx Environmental Advisory Board
Chairman, Onyx Environmental Trust
Chairman, WAMITAB (Waste Management Industry Training & Advisory Board)
Director, Brett Environmental Trust

Earl of Lindsay

Non-Executive Director, Mining Scotland Ltd
Chairman, UKAS (United Kingdom Accreditation Service, which has been involved in designing the Carbon Trading Methodology)

Lord Oxburgh

Former adviser to European Commission on geothermal energy
Former Government-appointed Non-executive Director of NIREX
Non-executive Director (and interim Non-executive Chairman since 3 March 2004) of Shell Transport and Trading Company

Lord Paul

Chairman and Director, Caparo Group Ltd
Caparo Group Ltd is the beneficial owner of 8.11% of Eleco Holdings Plc
Board Member, London Development Agency
Vice President, Engineering Employers' Federation
Chancellor, University of Wolverhampton
Member, DTI Industrial Development Advisory Board
Member, Corporation of the Hall of Arts and Sciences
Co-chairman, UK-India Round Table
Member, Board of London 2012
Non-Executive Director, London 2012 Ethics Advisory Group
Chairman, Piggybankkids charity, and its trading subsidiary; Piggybankkids Projects Ltd
Trustee, Ambika Paul Foundation

Baroness Platt of Writtle

Former Director, British Gas Plc (1988-94)
Voluntary Member, Campaign to Protect Rural England
Member, Essex County Council (1965-86)

Baroness Sharp of Guildford

Visiting fellow, Science Policy Research Unit, University of Sussex

Lord Taverne

Patron of Supporters of Nuclear Energy (SONE);
Chair of Sense About Science

Lord Wade of Chorlton

President, Combined Heat and Power Association
President, Campus Ventures Ltd
Chairman, Nimtech Ltd
Chairman, Stirling Energy Systems Ltd

APPENDIX 2: WITNESSES

The following witnesses gave evidence; those marked with * gave oral evidence:

A Power for Good Ltd

* Mr Paul White, AEA Technology:

Aluminium Federation:

* Mr Mark Askew

* Dr David Harris

* Mr Andrew Warren, Association for the Conservation of Energy

* Professor Tadj Oreszczyn, Bartlett School of Environmental Studies

* Mr Mike Gilbert, British Cement Association

Ms Sonia Boehmer-Christiansen

British Gas:

* Mr Jon Kimber

* Mr Patrick Law

British Nuclear Fuels Plc

* Ms Lynne Sullivan, Broadway Malyan

* Dr Leonard Brookes

Building Research Establishment:

* Mr Roger Hitchin

* Dr Martin Wyatt

* Professor David Strong, BRE Environmental

Calor Ltd

The Carbon Trust:

* Mr Tom Delay

* Mr Peter Mallaburn

* Mr Michael Rea

* Mr David Vincent

* Mr Richard Boarder, Castle Cement

Cavity Insulation Guarantee Agency and National Insulation Agency

Combined Heat and Power Association:

* Mr Syed Ahmed

* Mr Ian Calvert

* Mr David Green

Confederation of British Industry:

* Mr Matthew Farrow

* Dr Davis Welsh

Defra:
* Mr Chris Baker
* Mr Paul Chambers
* Dr Hunter Danskin
* Mr Jeremy Eppel
* Ms Jackie Jones
* Ms Marie Pender
* The Lord Whitty
* Ms Jayne Law, DOW Chemicals Europe
The Energy Advice Provider's Group
The Energy Retail Association
The Energy Saving Trust:
* Mr Tim Curtis
* Mr Nick Eyre
The Environmental Industries Commission
* Mr Steve Irving, Faber Maunsell
Ms Tina Fawcett
Fells Associates
Mr John Field
* Professor Sandy Halliday, Gaia Research
George Wimpey UK
* Mr Robert Harrison
Dr Mayer Hillman
House of Lords:
* Mr Henry Webber
* Sir Michael Wilcocks KBE
* Mr Ian Hornby, House Builders' Federation
The Institute of Physics
The Institute of Refrigeration:
* Mr Ray Gluckman
* Dr Guy Hundy
The Institution of Electrical Engineers
Intellect:
* Mr Peter Evans
* Mr George Fullam
* Mr Alan Meier, International Energy Agency
National Energy Action

* Mr Simon Barnes, Office of the Deputy Prime Minister
Ofgem
* Ms Janet Young, the Peabody Trust
The Planning Officers' Society
Research Councils UK
The Royal Academy of Engineering
The Royal Society
The Royal Society for the Protection of Birds
Sciotech
Scottish and Southern Energy Plc:
* Mr Alistair Phillips-Davies
* Mr David Sigsworth
Solar Thermal
Mr Paul Spare
* Mr Richard Starkey, Tyndall Centre for Climate Research
UK Energy Research Centre:
* Professor Paul Ekins
* Professor Jim Skea
United Utilities
* Professor Geoff Hammond, University of Bath

The following submitted papers which were not treated as formal evidence:

Ms Lynne Sullivan, Broadway Malyan
EAGA
Genersys Plc
Kodak
House Builders' Federation
Mr Robert Hubbard
Mr Peter Calliafas

APPENDIX 3: CALL FOR EVIDENCE

The Science and Technology Select Committee of the House of Lords has appointed a Sub-Committee, chaired by Baroness Perry of Southwark, to inquire into the Government's policies on energy efficiency.

The Government's goal, set out in the 2003 Energy White Paper,[113] is to achieve a 20 percent reduction in carbon dioxide emissions by 2010—half of this reduction is expected to derive from energy efficiency. In the long-term the Government proposes to reduce emissions by 60 percent by 2050. These are very ambitious targets. In addition, the recent energy efficiency Action Plan[114] estimates that there is potential to reduce energy use across the economy by 30 percent.

The Committee invites evidence on the policies currently in place, and on any other practical steps necessary, in order to achieve the Government's targets. We are interested in the following areas:

- The most appropriate measure of energy efficiency, and the relationship between improvements in energy efficiency and overall energy use and carbon emissions.
- The behavioural aspects of energy efficiency schemes—the quantity and quality of information available on energy efficiency, and whether the public is sufficiently knowledgeable and motivated to achieve energy savings.
- The scope and incentives for improving energy efficiency, and reducing waste, across the economy, in both private and public sectors.
- The potential for technological improvements to the energy efficiency of new and existing buildings, and how these should be implemented.
- The development and promotion of energy-efficient consumer goods.
- Innovative schemes to use district heating or combined heat and power in order to reduce overall energy demand.[115]
- The funding and co-ordination of research into energy efficiency measures in the domestic and industrial sectors, and how well research is transferred into applications.

Please note that in light of recent inquiries by the House of Commons Environmental Audit and Transport Select Committees, on aviation and "cars of the future" respectively, the Committee will not be looking at transport in this inquiry.

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113 *Our energy future—creating a low carbon economy*, presented to Parliament in February 2003 (Cm 5761).

114 See http://www.defra.gov.uk/environment/energy/review/index.htm.

115 The Committee will not be addressing trading arrangements for established CHP generation.

APPENDIX 4: TRENDS IN DELIVERED ENERGY CONSUMPTION AND ASSOCIATED LIFE CYCLE CARBON DIOXIDE EMISSIONS[116]

Introduction

Statistics for UK domestic energy consumption, broken down by end-use, are published annually by the DTI [1]. Figures for the period 1990–2002, in thousands of tonnes of oil equivalent (ktoe), are shown in Table 1. Corresponding figures in PJ (petajoules: 1 PJ = 10^{15} Joules) are shown in Table 2, based in the conversion 1 ktoe = 42.0 TJ (Terajoules; 1TJ = 10^{12} Joules) [2]. A graph of the Table 2 figures is shown in Annex 1, Graph A.

The DTI also supplies a breakdown of these figures by fuel: solid fuel, gas, electricity and oil (see Annex 2). This means that if life cycle carbon dioxide emission values can be obtained for the UK for these types of fuel, it will be possible to derive accurate life cycle carbon dioxide values corresponding to the DTI statistics of Tables 1 and 2. The carbon dioxide value for electricity will need to be based on the current UK energy generating mix, and the solid fuel, gas and fuel oil figures will need to be based on current patterns of extraction, refining and supply. This is the goal of the calculations outlined in this document.

Calculation of life cycle carbon dioxide values for each fuel

Life cycle primary energy equivalents and carbon dioxide emissions associated with delivered energy have recently been studied [3]. The data in that source were taken from a detailed study carried out at ETH (Zürich) on the life cycle inventories of European energy systems [4]. This study, which is very widely used, produced detailed life cycle inventories of energy systems supplying Switzerland and those European countries connected through the European electricity grid (UCPTE—although the UK is technically connected to the UCPTE through the DC link with France it does not play a part in its operation). Because the ETH study does not specifically examine UK energy systems, the results are not precisely representative of the UK. However some of the results in [3] can be applied to the UK: for example, energy derived from oil from the North Sea. Therefore this source has sometimes been used here for data on primary energy equivalences and carbon dioxide emissions associated with delivered energy. In other cases, where differences exist, these have been highlighted and the reason for the use of different figures has been explained.

Life cycle carbon dioxide emissions from heating oil and natural gas

The heating oil studied in [3] is a low sulphur fuel based on the European average extraction and supply system. The oil is supplied to domestic users to fuel a 100 kW boiler to provide 1GJ of heat. The supply value for CO_2 emitted is 0.0135 g/MJ and the use value is 0.084 kg/MJ. In the UK in domestic homes, kerosene is generally used for heating. This has a lower carbon content of 0.24 $kgCO_2$ per kWh or 0.0667 $kgCO_2$ per MJ [5]. Further, in general in the UK the distances in distribution of heating oil from point of extraction to the refinery, and in distribution from the refinery to the consumer will be less than in the European data. However, the greenhouse gas emissions in this life cycle are mainly

[116] Report commissioned by the Committee, and prepared by Dr Phil Sinclair MA CertEd MSc PhD, of the University of Surrey.

Total UK domestic energy consumption by end use (DTI, 2004) (ktoe)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	23563	27287	26515	27686	26089	24769	30063	26559	27966	27786	28423	29921	28884
Hot water	10042	10185	10287	10562	10514	10540	10638	10762	10646	10727	10786	10906	11119
Lights & Appliances	5438	5610	5586	5653	5719	5776	5830	5891	5955	6016	6079	6136	6209
Cooking	1507	1478	1435	1407	1384	1364	1350	1339	1328	1319	1310	1303	1296
Total	40550	44559	43823	45308	43705	42449	47880	44551	45895	45847	46597	48265	47508

Total UK domestic energy consumption by end use (DTI, 2004) (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	989.6	1146.1	1113.6	1162.8	1095.7	1040.3	1262.6	1115.5	1174.6	1167.0	1193.8	1256.7	1213.1
Hot water	421.8	427.8	432.1	443.6	441.6	442.7	446.8	452.0	447.1	450.5	453.0	458.0	467.0
Lights & Appliances	228.4	235.6	234.6	237.4	240.2	242.6	244.8	247.4	250.1	252.7	255.3	257.7	260.8
Cooking	63.3	62.1	60.3	59.1	58.1	57.3	56.7	56.2	55.8	55.4	55.0	54.7	54.4
Total	1703.1	1871.5	1840.6	1902.9	1835.6	1782.9	2011.0	1871.1	1927.6	1925.6	1957.1	2027.1	1995.3

concentrated in the conversion of the fuel into heat, so the effects of these differences are likely to be minor.

Higher CO_2 emissions from heating oil arise principally from energy use in the refinery and also from gas flaring during extraction. Therefore, the use figure in this paper has been modestly adjusted downwards to 0.01 $kgCO_2/MJ$, giving a figure for the total CO_2 emissions of 0.077 kg/MJ delivered.

With respect to natural gas, figures have been used in this paper which are likely to be similar and representative of North Sea fuel. The enthalpy of burning methane to gaseous carbon dioxide and water vapour is 802.3 MJ/kmol; therefore the net calorific value is 802300/16 MJ/kg = 50.144 MJ/kg; similarly the gross calorific value is 55.644 MJ/kg (since the higher enthalpy value is 890.3 MJ/kmol). Hence per MJ of heat released, the kg of CO_2 released are respectively for net, 0.054842 and gross, 0.049421. Compare this with another source with the values 0.05374 $kgCO_2/MJ$ for net and 0.05254 $kgCO_2/MJ$ for gross [6]. For gas, emissions from the supply chain are much smaller than for oil. Therefore a representative median figure has been taken of 0.053 $kgCO_2/MJ$ gross.

The supply used (i.e. total) CO_2 emitted for heating oil is 0.077 kg/MJ [5]

The supply and use value for natural gas life cycle is 0.0530 kg/MJ [6]

Life cycle carbon dioxide impacts from solid fuel heating

The system for calculating life cycle coal emissions in [3] was derived from data on the French hard coal-fired electricity generation system, because of its similarity to the UK system, and then adjusting for the average prevailing total efficiency of European coal-fired electricity stations of 28.5 percent. The DTI provide a figure for the gross calorific value of house coal of 31.0 GJ/tonne [7], while $kgCO_2$ emitted per tonne of coal burned is 2,419 [8]. Thus the use figure for domestic solid fuel heating is 0.078 kg/MJ. To this must be added a modest total of 0.01 kg/MJ emitted from production and supply, to yield total CO_2 emitted, covering both supply and use of 0.088 kg/MJ [7,8]. When adjusted by the 28.5 percent European efficiency figure this yields a total figure for European electricity from coal of 0.309 kg/MJ, which checks with the figure in [3] of 0.315 kg/MJ.

Life cycle carbon dioxide impacts from electricity generation

General Methods of electricity provision are split into conventional thermal, hydroelectric, nuclear and other (including imports).

Conventional thermal: The conventional thermal figures are based on the emission figures already established, adjusted for the efficiencies assumed to be prevailing [9] (Table 3). CCGT plants in particular, and other natural gas plants to a lesser extent, are known to be increasing in efficiency. The transmission of electricity in all cases is taken to be distribution from the power station via the high voltage electricity grid to low voltage electricity for domestic use.

Other conventional sources: These contribute very little to overall emissions; their supply and use figures have been taken to be the average between CCGT and non-CCGT gas figures.

Hydroelectric power: Few figures are available. The most reliable come from Scandinavia where hydroelectric power takes up a very large proportion of electricity generated. Vattenfall, the largest Swedish hydroelectric utility, have performed a detailed life cycle assessment, suggesting 11g GWP-equivalents/kWh [10]. This equates to:

The supply and use for hydroelectric power is approximately 11g/3.6MW = 0.0031 kg/MJ [10]

TABLE 4

Assumed variations in average efficiencies of UK electricity generation plant (Year 2000 figures from [9])

	1990 (est)	1995 (est)	2000	2003 (est)
Oil	0.25	0.25	0.25	0.25
Natural gas (CCGT)	0.4	0.43	0.46	0.49
Natural gas (non CCGT)	0.322	0.332	0.342	0.352
Coal for power stations	0.36	0.36	0.36	0.36

Nuclear energy: Two types of European nuclear reactor are common – the boiling water reactor (BWR) and the pressurised water reactor (PWR). Of these only the PWR is used in the UK (Sizewell B). The other types of reactor used in the UK are the advanced gas-cooled reactor (AGR) and Magnox power plants. These are peculiar to the UK and are not covered in [3]; therefore only electricity generation from the PWR is considered here. It is known that carbon dioxide emissions from nuclear power generation are very low; the figure is so low that variations in its value have no effect on the overall carbon dioxide intensity of the energy system, and we assume:

The supply and use value for nuclear energy is approximately 0.0031 kg/MJ.

Other non-conventional sources, and imports: These contribute very little to overall emissions; their supply and use figures have been taken to the average between the CCGT and non-CCGT gas figures.

Life cycle carbon dioxide emissions from UK electricity mix: These can now be calculated using the data and assumptions already made. In Table 4, the conversion efficiencies that have been assumed for thermal stations are shown in column A. Supply and use figures that have been assumed in this section are shown in column B.

The Digest of UK Energy Statistics gives data on the percentage of electricity supplied by the various generating sources [11]. These are shown in columns C0 for the baseline year 1990, and C1 and C2 for 1995 and 2003 respectively. For comparison, typical European values are shown in column D [4]. In columns E0, E1, and E2 are calculated the shares of carbon dioxide emissions from each of the generating sources on the left of the table, for the baseline year 1990, and for 1995 and 2003 respectively. These are summed to obtain carbon dioxide intensity values in kg/MJ for the whole generating mix.

The carbon intensity value for 1990 is presented as a range because the data in column C0 for that year was aggregated for the fuels coal, oil and non-CCGT gas. Even if the lowest value of this range were taken, there would still be a far sharper fall in CO_2 intensity from 1990 to 1995 (0.191kg/MJ to 0.147 kg/MJ) than from 1995 to 2003 (0.147 kg/MJ to 0.134 kg/MJ). This suggests that the basis upon which the 1990 figures were collected may not be properly comparable with that used for figures after 1995.

Nevertheless, the most likely value in the range is indicated by assuming likely shares of 1990 UK supply. Here, taking 62 percent for coal, 15 percent for oil and 1 percent for gas, the figure of 0.199 kg/MJ has been calculated. This figure is assumed in the remainder of this document. Further, two “paths” of carbon intensity are postulated. Path 1 (Table 5.1 Annex1, Graph P) shows steady downward progress from the 1990 intensity figure to the 2003 intensity figure, and ignores the 1995 intensity figure of 0.147 kg/MJ. Path 2 (Table 5.2; Annex 1, Graph P) assumes steady (sharp) downward progress between the 1990 figure and the 1995 figure, and then much less severe downward progress towards the 2003 figure. The historic trends of CO_2 emissions as implied by these paths, when matched against data from the Climate Change Inventory [12], are likely to yield useful information as to the historic and future course of CO_2 emissions, and to any possible errors in emissions statistics.

Calculation of overall carbon dioxide emissions from UK delivered energy statistics and life cycle carbon dioxide values for each fuel

Overall carbon dioxide emissions corresponding to each end-use can now be calculated. The statistics for domestic energy consumption in Annex 2 are combined with the carbon dioxide values of the previous section. An example of the methodology will not be presented for the calculation of the 1990 space heating contribution to carbon dioxide emissions. The contribution itself comes from four sources:

Solid fuels: calculated from 1990 space heating solid fuel value (2,643 ktoe), converted to TJ by multiplying by 42.0 [2], then multiplied by CO_2 for coal (0.088 kg/MJ), giving 9.77 Mt of carbon dioxide;

Gas: calculated from the 1990 space heating gas value (17,845 ktoe), converted to TJ by multiplying by 42.0 [2], then multiplied by CO_2 for gas heating (0.0530 kg/MJ), giving 39.72 Mt of carbon dioxide.

Electricity: calculated from the 1990 space heating electricity value (1057 ktoe), converted to TJ by multiplying by 42.0 [2], then multiplied by CO_2 for electricity for 1990 (0.199 kg/MJ, from Table 5.1 or 5.2 as appropriate to the path being calculated), giving 8.83 Mt of carbon dioxide for each path; and

Oil: calculated from 1990 space hating oil value (2,018 ktoe), converted to TJ by multiplying by 42.0 [2], then multiplied by CO_2 for heating oil (0.077 kg/MJ), giving 6.53 Mt of carbon dioxide.

The four sources total 64.9 Mt of carbon dioxide, for both paths in Table 6.1 and Table 6.2. Contributions have been calculated likewise for each year, and for each path, between 1990 and 2002. The results are shown in Tables 6.1 and 6.2 and in Graphs B1 and B2 of Annex 1. For comparison, the figures for CO_2 from the Review of the Climate Change Programme are also shown [12].

The results have also been converted to index values in Tables 7.1 and 7.2 and these are also shown in Graphs C1 and C2.

Table 4 Calculations of UK carbon dioxide intensity of electricity mix, for 1990, 1995 and 2003

	A0	A1	A2	B0	B1	B2	C0	C1	C2	D	E0	E1	E2
ELECTRICITY SOURCE	Assumed conversion efficiencies for thermal stations, %			Supply and use carbon dioxide kg/MJ			% of UK supply			% of European supply (for reference)	Shares supply and use kg/GJ		
	1990	1995	2003	1990	1995	2003	1990	1995	2003	1994	1990	1995	2003
HARD COAL	36.0	36.0	36.0	0.244	0.244	0.244	78	42	35	17.5	19.032-24.024	10.27	8.46
BROWN COAL	N/A	N/A	N/A	N/A	N/A	N/A		0	0	10.5		0.00	0.00
OIL	25.0	25.0	25.0	0.308	0.308	0.308		4	1	9.7		1.23	0.37
GAS (NON CCGT)	32.2	33.2	35.2	0.165	0.160	0.151		0.1	0	7.9		0.02	0.00
GAS (CCGT)	40.0	43.0	49.0	0.133	0.123	0.108	0.1	21	38	0	0.01	2.59	4.12
OTHER GASES	36.1	38.1	42.1	0.149	0.141	0.129	0	0.9	0	1.9	0.00	0.13	0.12
TOTAL CONVENTIONAL THERMAL							78.1	68	74	47.5	19.033-24.025	14.23	13.06
HYDRO-POWER				0.0031	0.0031	0.0031	2.4	0.5	1	15.2	0.06	0.09	0.07
NUCLEAR				0.003	0.003	0.003	19.5	28.5	22	36.9	0.01	0.00	0.00
OTHER				0.149	0.141	0.129	0	1	2	0.4	0.00	0.14	0.22
IMPORTS				0.149	0.141	0.129	0	2	1	0	0.00	0.28	0.06
							100	100	100	100	19.103-24.032	14.74	13.42
				CARBON DIOXIDE INTENSITY (KG/MJ)							0.191-0.240*	0.147	0.134

*MOST LIKELY VALUE 0.199, WITH SHARES OF UK SUPPLY COAL 62%, OIL 15% AND GAS 1%.

Table 5.1 Assumed path of UK electricity mix CO_2 intensity (path 1: linear trend from 199kg/GJ in 1990 to 134 kg/GJ in 2003)

Assumed path of UK carbon dioxide intensity for electricity generation, kg/MJ													
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	*2001*	*2002*	*2003*
0.199	0.194	0.189	0.184	0.179	0.174	0.169	0.164	0.159	0.154	0.149	*0.144*	*0.139*	*0.134*

Table 5.2 Assumed path of UK electricity mix CO_2intensity (path 2: linear trend from 199kg/GJ in 1990 to 147kg/GJ in 1995, followed by a separate linear trend from 147kg/GJ in 1995 to 134kg/GJ in 2003)

Assumed path of UK carbon dioxide intensity for electricity generation, kg/MJ													
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	*2001*	*2002*	*2003*
0.199	0.189	0.178	0.168	0.157	0.147	0.145	0.144	0.142	0.141	0.139	*0. 137*	*0.136*	*0.134*

Table 6.1 Calculated CO_2 values for UK end-use sectors in Megatonnes CO_2, 1990-2002 (path 1). Figures shown in Graph B.1

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	64.9	75.6	73.1	75.5	71.2	67.2	81.5	71.4	75.7	74.5	75.3	79.5	76.1
Hot water	30.5	30.1	30.9	32.0	31.2	30.4	30.4	30.3	29.9	30.2	30.0	30.4	30.2
Lights & Appliances	45.5	45.7	44.4	43.7	43.0	42.2	41.4	40.6	39.8	38.9	38.0	37.1	36.3
Cooking	7.6	7.3	7.0	6.7	6.5	6.2	6.0	5.9	5.7	5.5	5.4	5.2	5.1
Total	148.4	158.8	155.3	158.0	151.9	146.1	159.3	148.2	151.1	149.1	148.7	152.2	147.6
Climate Change Inventory	152.9	150.5	148.1	145.6	143.2	140.8	141.6	142.4	143.2	144.0	144.8	145.6	146.4

Table 6.2 Calculated CO_2 values for UK end-use sectors in Megatonnes CO_2, 1990 – 2002 (path 2). Figures shown in Graph B.2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	64.9	75.3	72.5	74.7	70.1	65.7	79.7	70.2	74.4	73.5	74.5	78.9	75.8
Hot water	30.5	29.9	30.4	31.2	30.2	29.2	29.4	29.4	29.2	29.6	29.5	30.0	30.0
Lights & Appliances	45.5	44.4	41.8	39.8	37.8	35.7	35.6	35.6	35.6	35.5	35.5	35.4	35.4
Cooking	7.6	7.2	6.7	6.3	5.9	5.5	5.4	5.3	5.3	5.2	5.1	5.0	5.0
Total	148.4	156.9	151.4	152.1	143.9	136.1	150.2	140.5	144.5	143.7	144.6	149.4	146.2
Climate Change Inventory	152.9	150.5	148.1	145.6	143.2	140.8	141.6	142.4	143.2	144.0	144.8	145.6	146.4

Table 7.1 Calculated CO_2 values for UK end-use sectors (1990 = 100) (path 1). Figures shown in Graph C.1

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	100.0	116.6	112.6	116.4	109.7	103.7	125.6	110.1	116.7	114.8	116.1	122.6	117.3

Hot water	100.0	98.6	101.1	105.0	102.3	99.6	99.7	99.1	98.1	98.9	98.2	99.4	98.8
Lights & Appliances	100.0	100.6	97.6	96.1	94.6	92.9	91.0	89.3	87.5	85.6	83.7	81.6	79.7
Cooking	100.0	97.2	92.2	88.7	85.5	82.7	80.1	77.7	75.4	73.1	71.0	68.9	66.9
Total	100.0	107.0	104.6	106.4	102.3	98.4	107.4	99.8	101.8	100.5	100.2	102.5	99.4
Climate Change Inventory	100.0	98.4	96.8	95.3	93.7	92.1	92.6	93.1	93.7	94.2	94.7	95.3	95.8

Table 7.2 Calculated CO_2 values for UK end-use sectors (1990 = 100) (path 2). Figures shown in Graph C.2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	100.0	116.1	111.7	115.2	108.0	101.3	122.9	108.1	114.7	113.2	114.9	121.7	116.9
Hot water	100.0	97.9	99.6	102.4	98.9	95.6	96.4	96.4	95.6	96.8	96.6	98.3	98.3
Lights & Appliances	100.0	97.8	92.0	87.7	83.2	78.5	78.3	78.3	78.2	78.1	78.0	77.8	77.8
Cooking	100.0	95.1	88.2	82.9	77.9	73.3	71.9	70.8	69.6	68.6	67.6	66.6	65.8
Total	100.0	105.7	102.0	102.5	97.0	91.7	101.2	94.7	97.3	96.8	97.4	100.6	98.5
Climate Change Inventory	100.0	98.4	96.8	95.3	93.7	92.1	92.6	93.1	93.7	94.2	94.7	95.3	95.8

References:

[1] http://www.dti.gov.uk/energy/inform/energy_consumption/table/table3_7.xls July 2004.

[2] Conversion constant from http://www.eppo.go.th/ref/UNIT_OIL.html

[3] Michaelis, P, *Life Cycle Assessment of Energy Systems,* CES Working paper 05/00, Report to the UK Royal Commission on Environmental Pollution, 2000, ISSN 1464-8083

[4] Frischknecht, R, and Suter, P, *Environmental Life Cycle Inventories of Energy Systems,* ETH Zurich and Paul Scherrer Institute, Villigen 1996

[5] National Energy Foundation Website: http://www.natenergy.org.uk/oil-ch.htm

[6] From "The engineering toolbox" website; Fuel gases–Heating values for natural gas and corresponding conversion constants; http://www.engineeringtoolbox.com/heating-values-fuel-gases-9_823.html

[7] DTI energy statistics-calorific values; http://dti.gov.uk/energy/inform/table_a1_a2.xls

[8] Defra, guidelines for company reporting on greenhouse gas emissions, Annex 1 –fuel conversion factors; http://www.defra.gov.uk/environment/envrp/gas/05.htm

[9] Digest of UK Energy Statistics (2004), Table 5.10, June 2005; http://dti.gov.uk/energy/inform/dukes/dukes2004/index.shtml

[10] http://www.vattenfall.com/files/responsibilities/lcaeng_03.pdf ; pp 6-7

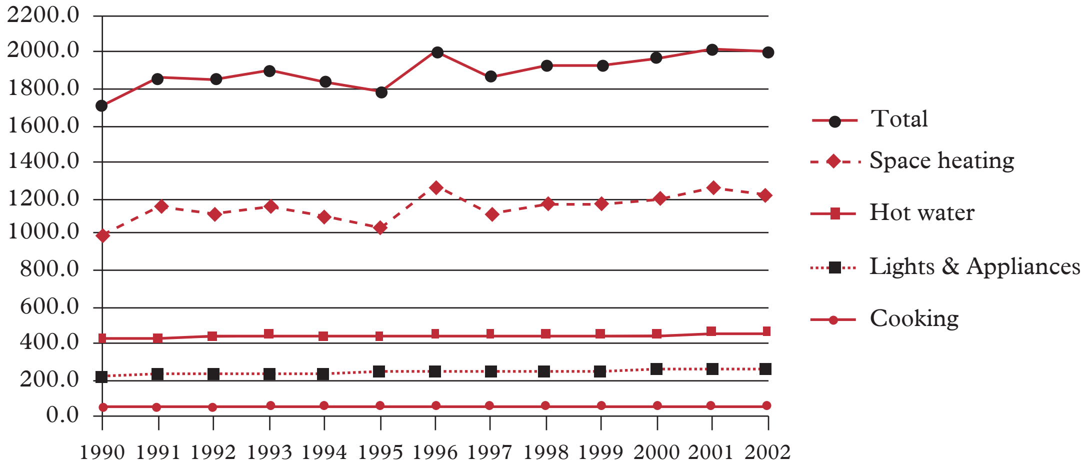
[11] Digest of UK Energy Statistics (2004), Tables 5.1.1, 5.1.3, and 5.6. On the recommendation of Mike James of ONS, Table 5.6 has been used for the 2003 figures; May 2005. http://www.dti.gov.uk/energy/inform/dukes/dukes2004/index.shtml

[12] Review of the UK Climate Change Programme, Table 6 (Residential sector, expressed in MtC: convert to $MtCO_2$ by multiplying by 44 and dividing by 12); http://www.defra.gov.uk/corporate/consult/ukccp-review/ccpreview-consult.pdf

Annex 1

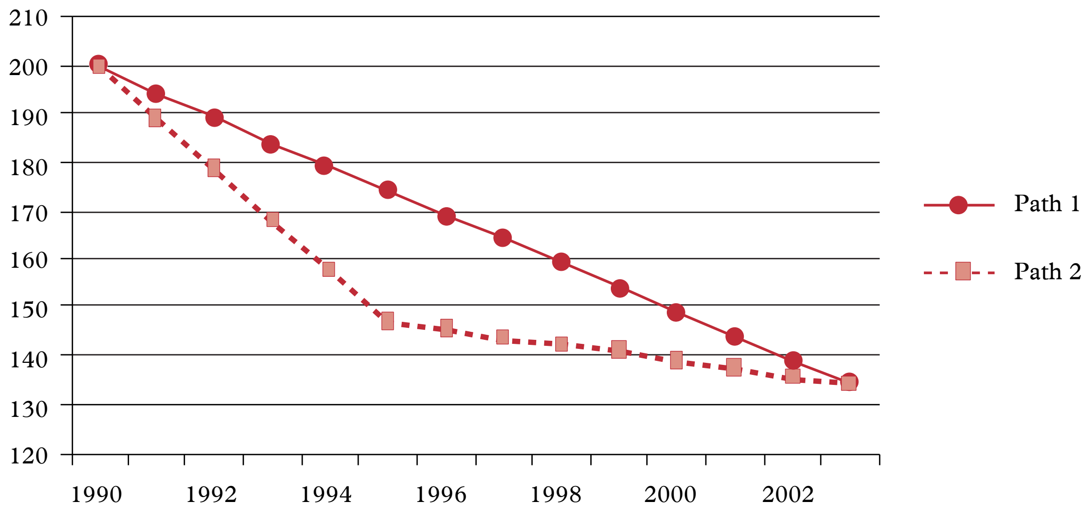
Graph A

Delivered energy consumption totals/PJ(1 PJ = 1E+15J)



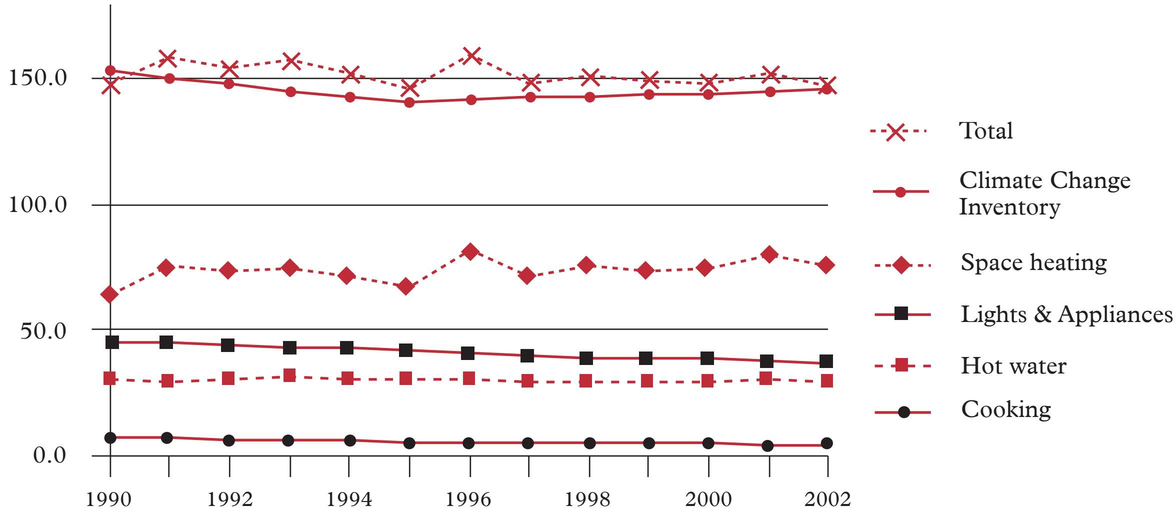
Graph P

Paths of carbon dioxide intensity for UK electricity generation, kg/GJ



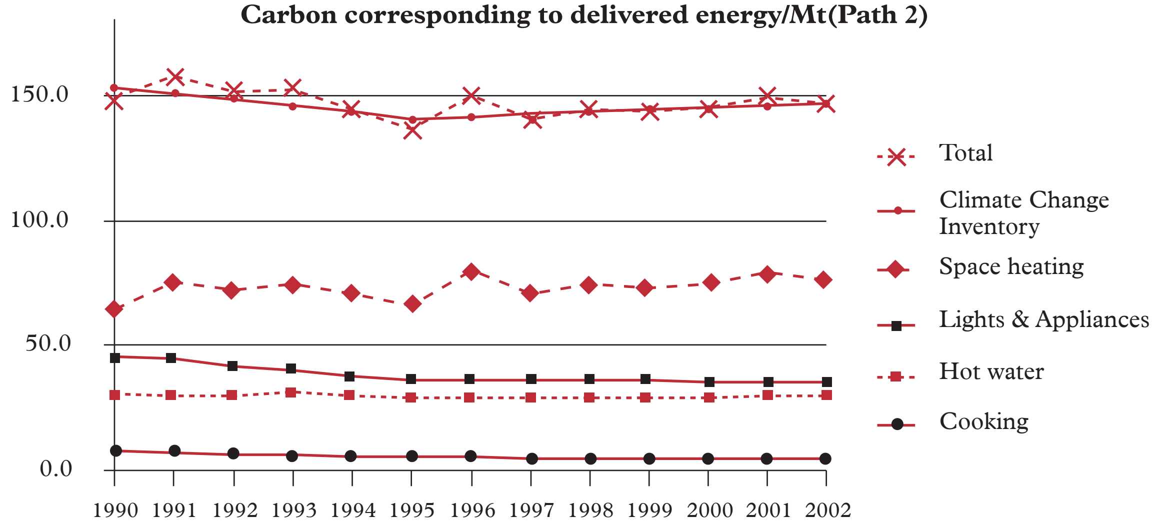
Graph B.1

Carbon corresponding to delivered energy/Mt(Path 1)



Graph B.2

Carbon corresponding to delivered energy/Mt(Path 2)



Graph C.1

Carbon corresponding to delivered energy(1990=100): Path 1

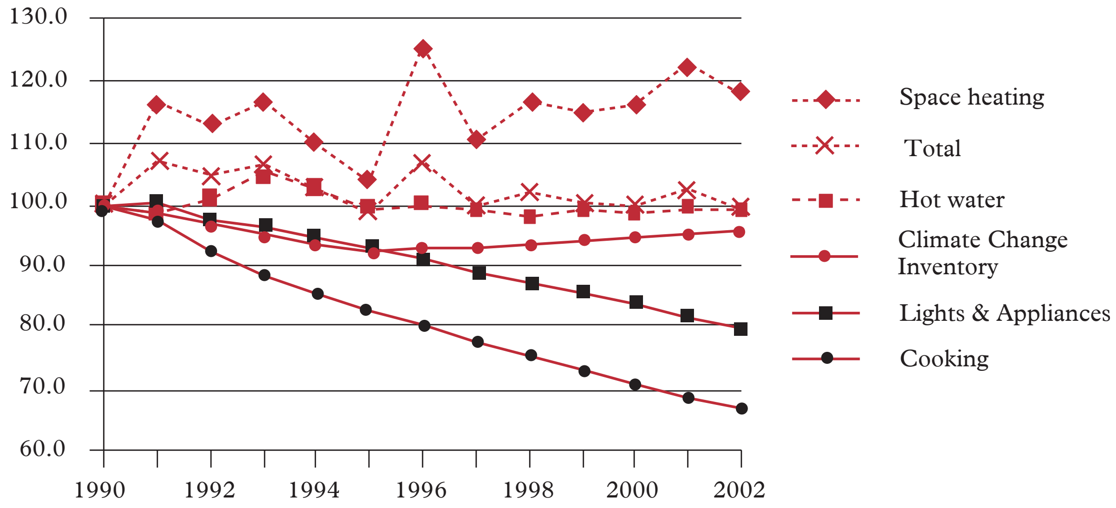
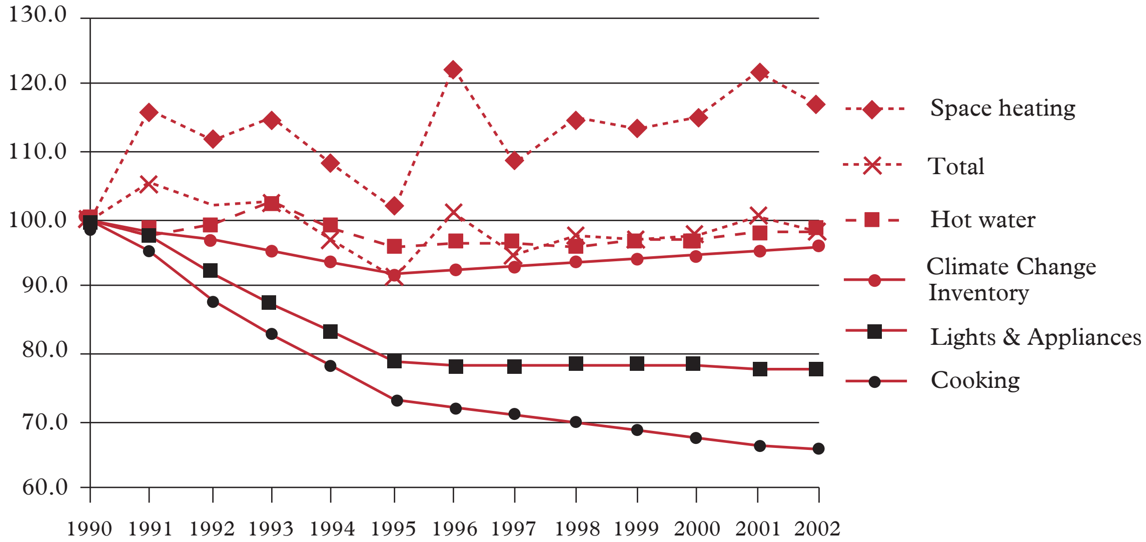


FIGURE 8C.2

Carbon corresponding to delivered energy(1990=100): Path 2



Annex 2

UK Domestic energy consumption by end-use and fuel, 1990 to 2002 (ktoe) [1]

SOLID FUEL	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	2643	3296	3040	3494	2885	2063	2223	1899	1778	1859	1498	1716	1309
Hot water	1511	1268	939	891	730	553	570	564	559	547	431	475	496
Lights & Appliances	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooking	14	13	12	11	10	9	8	7	7	6	6	5	5
Total	4169	4577	3990	4396	3625	2625	2801	2470	2343	2412	1935	2197	1810

GAS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	17845	20381	19953	20728	19624	19088	23472	20696	21568	21793	22662	23514	23044
Hot water	7186	7563	7676	7780	7998	8225	8128	8302	8326	8292	8446	8415	8623
Lights & Appliances	1	2	2	2	2	2	2	2	2	2	3	3	3
Cooking	802	775	758	744	732	722	714	710	705	701	697	693	689
Total	25835	28721	28389	29254	28355	28037	32317	29710	30601	30788	31806	32625	32358

ELECTRICITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	1057	1299	1276	1164	1218	1327	1777	1508	1788	1757	1816	2000	2028
Hot water	893	850	1039	1180	1152	1062	1019	969	1056	1108	1121	1185	1017

Lights & Appliances	5436	5608	5584	5651	5717	5774	5827	5889	5953	6013	6076	6133	6206
Cooking	679	679	655	644	634	627	621	616	611	607	603	600	597
Total	8066	8436	8555	8639	8721	8790	9244	8982	9408	9485	9617	9917	9848

OIL	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	2018	2310	2247	2300	2362	2291	2592	2456	2832	2377	2447	2691	2504
Hot water	451	504	633	711	634	699	920	927	705	780	787	831	983
Lights & Appliances	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooking	11	10	9	9	8	7	7	6	5	5	5	5	5
Total	2480	2825	2889	3019	3004	2997	3518	3389	3543	3162	3239	3527	3491

Total UK domestic energy consumption by end-use and fuel (ktoe)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Space heating	23563	27287	26515	27686	26089	24769	30063	26559	27966	27786	28423	29921	28884
Hot water	10042	10185	10287	10562	10514	10540	10638	10762	10646	10727	10786	10906	11119
Lights & Appliances	5438	5610	5586	5653	5719	5776	5830	5891	5955	6016	6079	6136	6209
Cooking	1507	1478	1435	1407	1384	1364	1350	1339	1328	1319	1310	1303	1296
Total	40550	44559	43823	45308	43705	42449	47880	44551	45895	45847	46597	48265	47508

APPENDIX 5: SEMINAR HELD AT THE INSTITUTION OF ELECTRICAL ENGINEERS

19 October 2004

A seminar was organised at the Institution of Electrical Engineers to give the Committee an opportunity to discuss issues connected to the inquiry with a number of experts in the field, along with representatives of Government and the regulator, Ofgem.

Members of the Sub-Committee present were Lord Broers, Lord Lewis of Newnham, Earl of Lindsay, Lord Oxburgh, Lord Patel, Baroness Perry of Southwark (Chairman), Baroness Platt of Writtle, Baroness Sharp of Guildford and Lord Wade of Chorlton. Also present were the Committee's Specialist Adviser (Professor Roland Clift), the Clerk (Christopher Johnson), and the Specialist Assistant (Dr Jonathan Radcliffe).

The participants were: Ken Bromley (ODPM), Brenda Boardman (Environmental Change Institute, Oxford), Paul Chambers (Defra), John Chesshire (Science Policy Research Unit, University of Sussex), David Cope (Parliamentary Office of Science and Technology), Gerald David (IEE), Jeremy Eppel (Defra), Nick Eyre (Energy Saving Trust), David Fisk (Imperial College), Nick Hayes (Building Research Establishment), Chris Lambert (Westminster Energy Forum), Peter Mallaburn (Carbon Trust), Alan Meier (IEA), Gerry Miller (Cavity Insulation Guarantee Association), Christopher Mills (NHBC), Nicholas Moiseiwitsch (IEE), Boaz Moselle (Ofgem), Tadj Oreszczyn (University College London), Michael Rea (Carbon Trust), Jes Rutter (JRP Solutions), David Vincent (Carbon Trust), Andrew Warren (Association for the Conservation of Energy), Roger Webb (Society of British Gas Industries), Paul White (Market Transformation Programme, AEA Technology).

Morning

The day began with the following presentations:

John Chesshire, "Setting the scene - Government policy, targets and measures"

Michael Rea, "Energy efficiency and a low carbon economy"

Tadj Oreszczyn, "Energy efficient buildings—Building regulations, new build, retrofitting, office buildings"

Nick Eyre, "Sustainable energy solutions in the home"

Paul White, "Energy efficient consumer goods—historical developments and future direction"

Brenda Boardman, "Behaviour of consumers—how does the public react to various energy efficient measures?"

Afternoon

An informal presentation was made by Alan Meier, on international trends in energy use and product standards. This was followed by general discussion.

APPENDIX 6: VISIT TO THE BUILDING RESEARCH ESTABLISHMENT, WATFORD

3 December 2004

Members visiting the Building Research Establishment were: Lord Lewis of Newnham, Baroness Perry of Southwark (Chairman) and Baroness Sharp of Guildford. In attendance: Dr Christopher Johnson (Clerk).

Presentation by Martin Wyatt, CEO, Building Research Establishment

Mr Wyatt summarised the history of the BRE, from its establishment after the First World War, when it focused on improved use of materials for housing, to its privatisation in 1997. At that time 95 percent of the BRE's work had been for Government, a figure that had now dropped to around 40 percent. At the same time the BRE's efficiency had significantly improved.

The BRE was a company, wholly owned by a Charitable Trust, the BRE Trust. The BRE and a second wholly-owned company (BRE Certification Ltd) gift-aided all their profits to the Trust, which in turn returned them in order to fund research, contributing to the public good.

The BRE was dedicated to providing sustainable building solutions, covering such areas as risk management, fire and security, environmental impacts, and so on. The company had a turnover of around £40 million per annum, and funded 20 PhD students; it was also, together with the Royal Academy of Engineering and the EPSRC, setting up three to five Centres of Excellence associated with universities.

BRE Certification was involved in EU "CE" certification—although as the United Kingdom was the one Member State not to sign up to the "CE" regime, it was likely that large quantities of non-CE compliant goods would be dumped here.

BRE was also closely involved with the labelling and certification of buildings in respect of the Performance of Buildings Directive, mainly through the Directive Implementation Advisory Group (DIAG), which BRE chaired and provided the secretariat. This required Member States to establish minimum performance standards for new build and major refurbishment. It also required certification of energy performance (though no obligation to make improvements) whenever buildings changed hands, either through sale or renting. By 2009 up to 20,000 people would be employed in certification. The training for these people would not be very onerous for qualified surveyors—it would be roughly equivalent to an NVQ. However, no arrangements were yet in place for this training. The BRE had also been in discussion with Government regarding the possibility of tying energy efficiency incentives (such as stamp duty rebates) to the certification process.

On the question of relations with the Government, Mr Wyatt noted that the construction sector represented some ten percent of GDP, and 20 percent of GDP growth. It employed some three million people. However, there were no dominant players—no one company controlled more than two percent of the market. Instead there were many thousands of SMEs. This meant that the private sector was not equipped to fund expensive research, and therefore historically the Government had worked in partnership with the BRE to conduct applied science research. A similar pattern could be observed in other countries.

Arrangements for funding research had been reviewed regularly, most recently by Sir John Fairclough in his 2002 report *Rethinking Construction Innovation and Research*, who had recommended increased funding for building research. However, after the last election in 2001, responsibility for construction had been moved to the DTI, which had little interest in construction. The DTI had in fact agreed to cover only 10-15 percent of the subject areas previously covered—predominantly those "high-tech" areas of less relevance to construction. No Department had accepted responsibility for the remaining 85-90 percent of funding, with the result that without any conscious policy decision being made Government support for the bulk of applied science research had simply stopped—as had the research itself.

Presentation by David Strong, Managing Director, BRE Environmental

BRE Environmental consisted of around 220 people, focusing on the environmental aspects of construction. The energy used in buildings accounted for nearly half of total United Kingdom carbon emissions, with a further ten percent accounted for by the construction industry. The waste generated from construction was about 35 percent of total UK waste (about 150 million tonnes per annum), and the industry used about six tonnes of building materials per head of population per annum.

BRE Environmental's goal was to develop solutions to deliver sustainable buildings—for instance, balancing insulation against ventilation to ensure both energy efficiency and health. The BRE Environmental Assessment Method (BREEAM) had been developed as the de facto methodology for setting standards for overall environmental sustainability. It was likely that ODPM's proposed sustainability code would be closely based on BREEAM. However, there appeared to be a concern within ODPM that the BRE might be given a monopoly if BREEAM were simply adopted. As a result there was a possibility that Government would seek to "reinvent the wheel", developing a new code of practice, and establishing a new agency to administer it. The BRE had offered to assign ownership of BREEAM wholly to the BRE Charitable Trust in an effort to allay these concerns. The Sustainable Buildings Task Group had recommended that the Government and BRE establish a joint venture to take things forward, but so far the Government had failed to engage with the BRE.

The aim of BREEAM was to drive the environmental performance of buildings beyond existing Building Regulations. The BRE did not itself conduct assessments, but trained and accredited independent organisations who conducted BREEAM assessments. Certification could be provided at design, construction or operation phases, though many clients were currently focusing on the design stage. BRE hoped to carry this forward to operation—one of the advantages of PFI was that it gave companies a 30-year contract to design and operate. Certification focused on the whole built environment, not just energy consumption.

Site visits

The Committee visited the following facilities within the BRE:

- Furnace/Burn Hall
- Exposure Rigs
- Environmental Chamber
- Test Houses

- Integer House
- Structures Laboratory
- Wind Tunnel
- Building 24
- Timber Library
- Environmental Office

APPENDIX 7: VISIT TO GERMANY

24-26 January 2005

Members of Sub-Committee II attending: Baroness Perry of Southwark, Lord Patel, Lord Oxburgh, Baroness Sharp of Guildford, Lord Paul. Also in attendance: Professor Roland Clift, Specialist Advisor and Dr Jonathan Radcliffe, Specialist Assistant.

Embassy briefing

Jeremy Cresswell, Deputy Head of Mission; Lynn Sheppard, First Secretary Environment; Sara Lines, Environment Officer

Mr Cresswell welcomed the Committee and briefed Members on the economic and political situation in Germany, noting the strong UK-Germany relations. Since the 1980s, Germany had been keen on international environmental regulation, having suffered the effects of pollution from other countries. As a result of their taking the initiative, EU directives resembled German laws. It was noted that 80 percent of domestic environmental legislation originated in Brussels.

Environmental standards were now uniform across Germany. Prior to unification, half of the water in the former German Democratic Republic (GDR) had not been drinkable.

Germany had one third of the world's wind turbine capacity, and had almost reached its Kyoto target for reducing greenhouse gases by 21 percent. The Government, with a Green environment minister, had stated it would commit to a 40 percent reduction in greenhouse gases by 2020, if the EU set a 30 percent reduction target (though this was thought unlikely). In 2004 over nine percent of electricity came from renewable sources.

The German government was reviewing its climate change programme, and expected to focus on transport. Germany favoured taxing aviation fuel, compared to the UK's preferred approach of emissions trading.

Federal Government briefing

Dr Wolfgang Stinglwagner, Ministry of Economic Affairs and Labour (BMWA); Franzjosef Schafhausen, Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU); Wolfgang Ornth, Ministry of Transport, Construction and Housing (BMVBW); Dr Anneliese Bohn, Ministry for Education and Research (BMBF)

Officials from the Federal Government presented an overview of German energy policy. In 2002, energy intensity in Germany stood at 5.34 GJ/$1000 GDP, compared to 6.89 GJ/$1,000 GDP in the UK. This reflected a drop of almost 2 percent per annum between 1990 and 2001, the most in the IEA, and compared to 1.3 percent per annum for the UK. Over the same period, though final energy demand had fallen by 2.8 percent, electricity demand had increased by 8 percent. The Government had adopted a policy of phasing out nuclear generation, from its 27 percent contribution, by 2022. This was projected to lead to an increase in use of fossil fuel, forecast to supply 80 percent of electricity production, and might have implications on security of supply and the environment.

The Government was investigating CO_2 reduction technologies, including ways to improve the efficiency of power plants, and "carbon capture and storage" techniques. Support was being given to combined heat and power (CHP) by means of a feed-in tariff similar to that for renewables. CHP plant in the former GDR had been modernised to make it cost effective.

Industry was reducing CO_2 emissions through voluntary commitments. For example, the chemicals industry had accepted a 50 percent reduction over the period 1990–2012, the cement industry 28 percent, and the steel industry 22 percent. In the transport sector, the industry was committed to improving the fuel consumption of cars by 25 percent by 2005 compared to 1990. The question was now how to combine these commitments with the EU's Emissions Trading Scheme (ETS).

A challenge was reducing electricity demand from household electronics, set to reach an annual level of 55 TWh by 2010 (11 percent of overall demand, equivalent to seven big power stations), 2 TWh of which was standby and off-mode power consumption. A solution was required at an EU level, with an eco-design directive. The "Green TV", with standby consumption of 0.25W, demonstrated that it was technically possible.

Eco-taxes were levied on transport and energy use, vehicle tax was set according to CO_2 emissions, up to €1,000, and new technology was being used to charge heavy goods vehicles according to motorway usage. Overall mileage had decreased since the tax was introduced in 1999, with 2.5 $MtCO_2$ saved.

Buildings were responsible for 35 percent of energy consumption. Germany's housing stock consisted of 75 percent built before 1975, with 17.5 million residential buildings, of which 12.5 million were one or two family households.

In the buildings sector, Kyoto targets had almost been met, but the trend in emissions was upwards because of a desire for more living space. Low interest rate loans were available for renovations from the state-owned bank KfW, which had funded €4.5 billion worth of energy saving projects.

Energy conservation regulations from 2002 increased requirements for thermal insulation such that energy demand for space heating should be no more than 70 kWh/m^2 a year for new buildings. The new EU Directive would require energy certificates for existing residential building and new national standards for lighting and air conditioning of non-residential buildings.

The German research ministry funded four programmes of energy research carried out at Helmholtz Centres: renewables, energy efficiency, nuclear fusion and nuclear safety, amounting to about €210 million. €40 million was dedicated to energy efficiency, focusing on how to use fuel more efficiently in new power plants, fuel cells and the use of superconductivity technology. Other government departments agencies and the *Länder* also funded research.

Federation of German Consumer Organisations (VZBV)

Dr Krawinkel, Head of Department, Construction, Energy and Environment

The Federation of German Consumer Organizations provided free, independent, advice to assist in the decision making process when buying appliances or buildings. It spent €4 million a year, providing 80 thousand advice sessions. Initial advice was free, with further consultation on site charged at €35, a subsidy of €140.

There was a strong regional divide—those in northern Germany used the service much more than those in the south. Regional campaigns had shown that awareness of standby power consumption could be raised to 40 percent, but it was an expensive method and would be easier to control by enforcing tighter standards.

German Energy Agency (DENA)

Annegret-Cl. Agricola, Head of Division, Energy Efficiency in the Electricity Sector; Felicitas Kraus, Head of Division, Energy Efficiency in Buildings

On energy labelling for buildings:

The German Energy Agency (DENA) employed 75 people, covering energy efficiency and renewables. It was owned 50:50 by the Federal Government and state-owned bank, KfW.

EU co-ordination in advance of the forthcoming buildings Directive was only just starting, and thought to be too little, too late. Innovation in the buildings sector was seen to have a low impact on carbon emissions. It was felt that energy consumption when buying a building was not a decision factor for consumers.

Two types of energy label had been field-tested: one similar to that used for appliances, with A–I ranking (category 'A' allowed space heating up to 80 kWh/m^2 a year); the other was a softer touch sliding scale. The latter had been chosen for implementation. The full *Energiepass* certificate ran to several pages, including information on insulation, heating systems and CO_2 emissions, and recommendations for renovations.

Two methods of energy use assessment had been tried: individual analyses of buildings issued by engineers, architects and energy consultants costing €350-€900; and a standardised analysis to be issued by trained master craftsman and chimney sweepers costing €100-350. Both considered building design rather than actual energy usage.

The field test had shown good results: lower costs than expected and the certificates were liked by private owners and landlords. The response was not so positive from housing companies: 30 percent of owners and landlords said the certificates gave a motivation to modernise the building, and 90 percent thought that a better rating would translate to higher market value.

The scheme would be implemented by 2006 for the domestic sector. The commercial sector was perceived to be harder, with energy calculations more complex.

On the Energy Efficiency initiative:

The German energy efficiency campaign was launched in 2002, and being re-launched in 2005. It put across a basic message that consumers could avoid unnecessary electricity consumption by making intelligent decisions when buying and using household equipment, leading to reduced bills and carbon emissions.

Information was provided at the point of sale—DENA worked in co-operation with about 7,000 retailers (both local and national chains)—and through advertising/press reports.

The Committee was impressed by simple cardboard "calculators" which allowed consumers to work out the energy consumption and running costs of appliances.

The Committee visited a demonstration fuel cell project operated by Vattenfall Europe.

Berlin Energy Agency

Frau Furth-Deutschländer, Berlin Ministry for Urban Development, Environment and Technology; Ralf Goldmann, Division Manager, International Know-How Transfer, Berlin Energy Agency; Bernd Schulz, Manager, Saar Energie AG

The Berlin Energy Agency is a public-private partnership between the Berlin Government, the energy supply company Bewag, and state-owned bank KfW. It was founded in 1992, has a staff of 29 specialists and turnover of €4 million.

Berlin had 6,000 public buildings with annual energy costs of €250 million and emissions of 3 $MtCO_2$. The Energy Concept Bill passed in 1994 set a target to reduce carbon emissions by 25 percent by 2010 compared to 1990 levels.

Energy Saving Partnerships were created to manage the energy requirements for a pool of (typically tens of) buildings, such as schools, swimming pools or prisons. Private third party finance was used to modernise systems and services, reducing costs and energy use, with savings shared between the private company and public body.

For each pool a contract would be drawn up, specifying the cost sharing and period (normally between 10 and 15 years). The private company would take on all initial investment costs, and then take 70-90 percent of the savings made. The return on investment stood at about 10 percent. Pools of buildings helped spread the risk.

A baseline of the energy consumed in the previous three years was used against which to establish potential savings. Contracts were then put out to tender. Bids had to show detailed investment plans. There had not been any cases where contractors had failed to fulfil the terms of the contract.

There were 17 pools, covering 361 buildings. Carbon dioxide emissions had been reduced by 100,000t, and the city had guaranteed savings of €9 million. Total initial investment stood at €37 million.

The contracts were standardised and transferred to the new Member States of the EU through a European platform (see www.clearcontract.net).

The Committee then heard from Saar Energie, which had won three pools, covering about 100 sites across Berlin. It needed well trained staff, with experts on energy management systems and contracts. It was felt that this expertise was lacking in the UK.

The investment phase for a pool lasted about a year, followed by 10-14 years of operation. Modern building controls were managed remotely from the company's Berlin office. It was essential for the utility meters to communicate with the control system so that savings could be measured. Such systems were sub-contracted to specialist companies.

Saar was achieving energy savings of about 25 percent below the baseline. It was in its eighth year of operation with running costs about €250,000 a year. The initial analysis of a project took about 5 percent of the investment budget. Long-term contracts gave confidence to investors, and included an option to continue operating at the end.

Reichstag

Manfred Jakel, Head, Energy Supply

The Committee visited the Reichstag Parliament building and heard about its energy management system. The contract for renovation of the Reichstag and construction of three new Parliament buildings, awarded to Foster and Partners, had specified an energy efficient design, and use of renewables.

A CHP plant (generating 380 kW of electricity and 320 kW of heat, along with 60 kW from low temperature waste heat) was fuelled by biodiesel from rape seed oil, achieving 82 percent efficiency. In the summer it could be used to provide cooling. The plant consumed five million litres of biodiesel a year, 1 percent of Germany's total production, and helped sustain jobs in the sector. A 10kV connection to the grid provided a back-up.

Boreholes provided access to underground heat and cold stores. In summer, the excess heat from the CHP plant heated water which was then pumped into porous rock 300 metres below the surface, and pumped back up for space heating in winter. At a depth of 60 metres, groundwater at 11°C was used as a coolant in summer.

Bavarian Ministry for Economic Affairs

Dr Martin Mitterer, Director, Energy Department; Dr Gerhard Olk, Head of Department, Energy Technologies; Bernhard Wiesner, energy efficiency and renewables

In Munich, the Committee met officials from the Bavarian Government. Energy was a priority for Bavaria because of its importance to economic development. Over 30 years Bavarian policy had developed a network of gas pipelines. Bavaria also had had the first trial nuclear reactor and power station in Germany. Nuclear now supplied two thirds of its electricity. Bavaria produced the most hydropower in Germany, but being so far inland was not a suitable region for wind turbines. It was felt that a broad energy mix was the best solution for avoiding an energy crisis.

Bavaria's carbon emissions were one third lower that the German average. After liberalisation prices had stabilised and did not restrict economic development. District heating was promoted where the housing density was high enough to justify it.

The *Länder* saw a risk in that federal policies were setting different priorities on energy policy by phasing our nuclear, increasing the price of energy, and giving high subsidies to wind power. *Länder* had some influence on national policy through the upper house (Bundesrat). Bavaria was in favour of retaining nuclear power, and restricting government intervention in the market.

Along with a neighbouring *Land*, Bavaria was funding research to improve the efficiency of coal power stations, aiming to increase efficiency by 25 percent. Industries in Bavaria had invested €150 million over seven years to improve processes. A similar amount had been invested in fuel cell technology. Voluntary agreements with industry were used to increase efficiency and reduce costs and carbon emissions.

Bavaria did not have state targets for energy efficiency, and it was felt that national targets should take account of geographical factors.

Fraunhofer Institute for Building Physics (IBP)

Professor Karl Gertis, Chair of Physics of Building and Structures, University of Stuttgart, and former Director of IBP

The Committee travelled to the IBP site in Holzkirchen outside Munich. Members heard from Professor Gertis, and were shown some of the Institute's facilities. The IBP had a budget of €12 million, 25 percent coming directly from central government (the Federal Research Ministry), the remainder from the marketplace, including 50 percent from private contract work, and 16 percent from public contracts. There were about 100 permanent staff across seven departments, but overall the IBP concentrated on heat technologies.

The work of the IBP was very market related, and it earned €1.2 million from licensing agreements. However, it was felt that the Federal ministry which had responsibility for construction was more interested in those transport issues falling within its remit.

On building construction, research showed that large thermal masses in buildings were beneficial, as they retained heat and slowed down temperature changes. However, architects preferred light partitions in buildings which led to rapid heating in the summer.

Though the Federal ministry thought that Germany would be ready for implementation of the buildings directive in 2006, Prof Gertis was more cautious. IBP had had input on the design of the standards through an EU working group, on which the Director sat.

APPENDIX 8: VISIT TO SWEDEN

31 January-2 February 2005

Members visiting Sweden were: Lord Broers, Lord Paul and Baroness Perry of Southwark (Chairman). In attendance: Professor Roland Clift (Specialist Adviser), Dr Christopher Johnson (Clerk).

Monday 31 January, Stockholm; Ministry for Sustainable Development

The Committee was welcomed to the Ministry for Sustainable Development by Mr Bo Diczfalusy, Director General of Energy Issues, and heard a series of presentations from Mr Diczfalusy and others.

Mr Diczfalusy began by noting that the new Ministry for Sustainable Development was still being organised, having been created in late 2004. It was one of ten Government Ministries, and had taken on elements of the responsibilities of the Ministries of Environment, Industry and Finance. There were two ministers, and it would employ around 200 people—Swedish central government ministries were typically small. The concept underlying the new ministry was that of a "green welfare state".

Patterns of energy use had been fairly stable for 30 years, though with an expansion in the use of electricity generated at nuclear power stations at the expense of oil in the 1970s, and more recently an expansion in district heating. About half of electricity generation was from hydro, while oil was now used only for transport. Biofuels were increasingly used for heating.

Sweden began from a position of relatively low carbon emissions, which it had achieved partly by the use of fossil-free sources for electricity, but also through energy efficient industry, high thermal standards in buildings, and the use of carbon taxes and other economic instruments. Energy policy was underpinned by guidelines agreed by the three major parties in 1997, and confirmed in 2002, which established principles of security of supply, competitiveness, health and environment. They also committed Sweden to the phasing out of nuclear power; efficiency of energy use; the promotion of renewables; and more use of CHP for district heating.

Sweden's climate strategy was currently under review. The long-term target was for emissions in 2050 to be not more than 4.5 tonnes carbon per capita, and Sweden planned a reduction in carbon emissions of 4 percent by 2010 (well ahead of its Kyoto obligations). The main instruments designed to reach these targets were EU Emissions Trading, green certificates and eco-taxes, and long-term agreements covering energy-intensive industries. On efficiency, the emphasis was on information and education, technological procurement and market transformation, along with reliance on local and regional initiatives.

Ms Kerstin Wennerstrand, Head of Section, Division for Eco-management, Industrial Co-operation and Building, focused on the need for balance between the various technical requirements for construction. Those covered by the Construction Products Directive fell into six categories: stability, fire safety, hygiene, security, noise protection, and energy economy. To these categories Sweden had added another three: fitness for use, accessibility and economical management of water and refuse.

Control was achieved at various levels. Acts of Parliament were backed up by Government decrees. At a lower level building regulations were set by the Board of Housing. These had since 1978 required a drop in annual energy consumption for a 75 m^2 apartment from 18,000 to 8,500 kWh for space heating and from 240 to 113 kWh/m^2 for hot water. However, energy consumption was currently increasing in Sweden, in part thanks to a fashion for larger windows.

There were also requirements for ventilation, in response to increases in asthma and allergies.

Mr Lars Roth, Head of Section at the Ministry for Sustainable Development, described the Local Investment Programmes for ecological sustainability. A grant system had been established in 1998, targeted mainly at municipalities. Programmes funded in 1998-2002 would continue to run until around 2006. About 212 programmes were running, supporting some 1,800 individual projects. Central government grants met 30 percent of the costs—the rest was raised by municipalities, in partnership with local industry. Energy savings, on the basis of 104 completed programmes, were projected to be of the order of 1.7 TWh/year.

The Local Investment Programme had now been renamed the Climate Investment Programme, with an exclusive focus on climate change.

Mr Bengt Nyman, a Government Adviser, said that he had been appointed to chair an inquiry into implementation of the Energy Performance of Buildings Directive, which would take effect from 1 January 2006. The Government was aiming to introduce an implementing bill in June, with a view to enactment before the end of the year. The National Board of Housing, Building and Planning would be responsible for supervision of the new regime, and would appoint an Advisory Board to follow up on implementation.

The Directive focused on consumers, introducing an obligation to present information on energy performance for buyers and tenants in a standardised manner. Implementation would require a significant training programme, which would take place during the introductory phase of 2006-08. Although there were enough expert inspectors to cope with the current market there was a need for additional training to meet new challenges, particularly the drawing together of the many strands that came together in the Directive. This should be possible by 2009.

The label required by the Directive would be known in Sweden as an “Energy Declaration”. The owner of a building would be responsible for having an Energy Declaration, prepared by an accredited Energy Expert. This would be displayed at the entrance of all public buildings—which would include those privately owned buildings which were intended for public use (in other words where the public gathered, for instance in cinemas, libraries, or private schools, but probably not supermarkets).

Mr Sven-Olov Ericson, Deputy Director of the Energy Issues Unit, addressed district heating (DH), noting that Sweden’s history of DH schemes went back more than 50 years. The technology was simple, but with heavy initial capital costs. It allowed the use of waste industrial heat and energy from waste, and these factors, combined with a drive towards energy efficiency and co-generation of heat and power, encouraged the early development of DH in Sweden. By using Combined Heat and Power (CHP) some 20-30 percent of primary fuel could be saved, compared with the separate generation of heat and electricity. In the 1960s and 70s, air quality in urban areas became an increasingly important factor, and

DH had played an important part in reducing the quantity of sulphur in the air in Stockholm by 98 percent.

A key feature of DH was the fact that low-cost fuel, such as the by-products of the wood industry, could be used. The emissions could then be filtered economically. In contrast, at domestic level filtration was not economically feasible, so only high-quality purpose-made biomass fuels could be used. The cost of such cheap biofuels was around €1.4c/kWh, compared with around €3.0c/kWh for electricity generation.

The waste heat from nuclear power generation was not used in DH. This was partly because of the geographical remoteness of nuclear plant, and also because the heat could not be taken from nuclear generators in useful quantities without serious loss of power output. In contrast, heat from coal-fired plant was readily used in DH. On normal days water was pumped into the DH networks at around 100°C, and returned at around 60°C—the relatively low temperatures allowed high electrical output to be maintained. High temperature steam was not used in Swedish DH.

DH was more efficient than small-scale heat generation—system losses were typically of the order of 10 percent. Other countries had experienced much higher losses—the key was insulation and efficiency. DH was mainly used by the residential, commercial and service sectors, which took heat from the system by means of heat exchangers.

Sweden's goal was to increase DH capacity by 20 percent. Biofuels were the largest contributor (some 60 percent), having replaced oil, which was the major fuel in the 1980s. Within biofuels, wood waste was the major fuel, with a small contribution from peat (though this would be hit by emissions trading). The total amount of peat used was only some 25 percent of the amount created annually. Energy crops such as short rotation coppice were a small contributor. Sweden was looking at the recovery of organic domestic waste, and had a permissive attitude to the use of non-separated organic industrial waste (such as crushed pallets). Mixed waste was also burnt, with about 90 percent recovery of heat for DH systems.

Mr Arne Andersson, of the Ministry for Sustainable Development and the Swedish Energy Agency, addressed energy efficiency in the housing sector. The focus was on technology procurement—the "art of buying what is not available". The steps in the process were, first, to define a need; then to identify the technical potential for a solution and a supplier capable of providing it; to establish a strong group of buyers, who would want a better solution than was currently available; and then to bring these parties together, so as to develop a dialogue between buyers and suppliers. The key was to identify buyers, creating a market demand. The focus as far as the product was concerned should be on functionality, but allowing space for innovation.

Once a winner in a procurement process had been identified, there was a prize ceremony, publicity, and guaranteed delivery to the buyers. It was essential for follow up with information campaigns to achieve wider acceptance. There might have to be an initial subsidy to get a product started.

Tuesday 1 February, Gothenburg; Lindås Housing Development

In the morning the Committee visited the Lindås passive housing development, in company with the architect, Mr Hans Eek. The development is about 20 km outside Gothenburg, on what used to be farmland, now owned by the city. Most residents commute to Gothenburg by car.

Mr Eek said that he had first begun to work on ecological design in the 1970s. The Swedish building code, which had mentioned energy efficiency as early as the 1930s, was the toughest in the world following its revision in 1975, requiring 21 cm of mineral wool insulation in external walls, 30 cm in roofs, and triple-glazed windows.

Mr Eek admitted that his early projects had been over-complicated and unsuccessful, with an over-reliance on mechanical devices. He had learnt from these experiences in the 1970s and 80s, as well as from a passive house in Arizona, which had demonstrated that designs for passive housing had to be varied according to the environment. In Sweden the priority was to find ways to take in heat, not to disperse heat. Heat was lost from houses in three ways: by means of hot water entering the sewage system; by transmission (walls and windows); by ventilation. Transmission losses could be minimised by good insulation, and by good windows and doors—the key was to control ventilation, making the house air-tight, and then ventilating by means of a heat exchanger.

The houses at Lindås were some four times as airtight as required by Swedish building regulations. Insulation was 43 cm thick in walls, 50 cm in the roof, and 30 cm under the floors. The houses were constructed in such a way as to create a continuous layer of insulation, avoiding heat bridges. The windows were wood-framed and triple-glazed, with krypton gas filling, and U-values of 0.85. The extra cost of these windows (as against those normally required by Swedish building standards) was around 15,000-20,000 SEK (some £1,200-1,500). Similar windows were available in the United Kingdom.

Other additional costs included the heat exchanger (some 10,000 SEK), the extra insulation (15-20,000 SEK), producing a total additional cost (as against required Swedish building standards) of some 40-50,000 SEK (roughly £3,000-3,800). This was offset by the fact that no heating system had been installed, making the buildings no more expensive to construct than conventional equivalents.

The houses each had one air inlet, where fresh air was passed through a heat-exchanger to warm it; it was then circulated around the house. Each house had three chimneys, one providing an outlet from the heat exchanger, the other two providing outlets for sewage and kitchen air, which were kept separate from incoming air. Overall 85 percent of exit heat was recovered via the heat exchanger.

The houses at Lindås were arranged so as to collect passive solar energy. Large windows faced south, taking in warmth in winter, but with roof overhangs and balconies to shade them in summer. Windows to the north were small, and illuminated rooms where less light is needed, such as bathrooms, kitchens, etc. Roof windows let light into the centre of the houses.

The average total heat output from occupants and appliances had been calculated at 11.72 kWh per day—equivalent to 500W continuous output. In the display house this was simulated by one electric heater. On a cold, frosty day (after several days of extremely cold weather) the display house was comfortably warm inside.

City Hall, Gothenburg

In the afternoon the Committee were welcomed to the City Hall by Ms Anneli Hulthén (Municipal Commissioner), for a meeting with Mr Göran Leander (Bostads AB Poseidon), Mr Bengt-Göran Dahlman (Technical Director of Göteborg Energi AB), and Ms Ulla Påhlman (Information Officer).

In the course of a preliminary discussion, Anneli Hulthén confirmed that the city of Gothenburg sought to integrate transport and planning. Cars were not discouraged as such, though a congestion charge was being considered. The main problem was commuters driving in from outside the city—a problem which would be eased when the current railway line, which terminated in the city centre, was extended. The planning board also sought to maintain green areas while providing the housing that was needed.

The municipality owned the energy company, Göteborg Energi, and this allowed the city to shape an energy strategy. However, there were those who advocated sale, which would provide a one-off windfall.

Göran Leander said that Poseidon owned 23,500 apartments, making it the largest housing company in Gothenburg. It also administered 1.5 million m^2 of green areas. The company's environmental concerns fell under four headings: energy consumption, handling of hazardous substances, the quality of the indoor environment, and waste management.

On the indoor environment, Poseidon had developed "p-labelling"—a certification scheme (administered by a state-run agency), the results of which were displayed in public areas. "P-labelling" encompassed a range of factors: temperature, air quality, moisture, hot water, radon, light, noise, and electrical or magnetic fields. On waste, it was estimated that 38 percent of waste was recyclable, and 33 percent biodegradable. That left 29 percent "residual" waste, such as plastic packaging, which was burnt. Providing facilities for tenants to sort waste reduced handling costs by half.

Attention was focused in three areas: investment (e.g. in metering equipment), operation and follow-up (e.g. the collection of data).

Poseidon had invested in a computer system (known as POSITIV). The system monitored demand, matched supply to demand, and noted peculiarities or unexpected fluctuations in demand. The temperature in every apartment block could be regulated from the central office.

As a result energy consumption had fallen from 186 kWh/m2 in 2000 to 157 kWh/m^2 in 2004. This represented a cost difference of 25 million SEK, compared to a capital investment in POSITIV of 100 million SEK (around £8 million). It was calculated that this saving was equivalent to a reduction in CO_2 emissions by around 1,900 tonnes per year. Over this period average temperatures in early December across the estate had varied only between 21.1 and 21.4 °C.

Information was the key to controlling energy use. At present monitoring was at the level of apartment blocks. The next challenge was to make tenants more aware of and better equipped to manage their personal consumption of energy. The cost of heating represented about 12-15 percent of total rent—around 100 SEK (roughly £8) per square metre per year.

Bengt-Göran Dahlman said that Poseidon was his largest single customer, though there were many smaller customers, for whom Göteborg Energi could monitor energy use. He reconciled the apparent contradiction of an energy company encouraging reductions in energy consumption by arguing that it was in the company's interest to encourage optimal energy use—although admitting that this approach derived from the company's owner, the City of Gothenburg. In addition, reduced demand meant a reduced need for investment.

District heating (DH) in Gothenburg covered an area with a radius of 20-30 km, and the total length of the network was around 700 km. The limit on the potential distance from generator to consumer was in practice economic, not technical—energy losses within the Gothenburg system were only 7-8 percent. The DH network was connected via heat exchangers to individual buildings, and was itself a closed loop with very little leakage. The water was pure, with no additives.

Pipes were steel, insulated and encased in plastic. Internal diameters could be as much as 1.1 metres. Pipes ran through pre-existing tunnels in places.

In 2002 the company bought 2,205 GWh of heat from outside sources, and itself produced 1,879 GWh of heat. 3,738 GWh were delivered to customers, and losses were 346 GWh. The 54 percent of bought-in heat was:

- Waste incineration (24 percent);
- Waste heat from two oil refineries (30 percent).

Heat generated by the company itself was derived from:

- Waste heat from co-generation (CHP);
- Sewage water;
- Natural gas;
- Oil (just 2 percent).

DH had evolved after the Second World War for two main reasons: a shortage of electricity, and poor air quality as a result of the proliferation of small coal-fired boilers. In the 1960s-70s, with the expansion of nuclear power, there had been resistance to CHP from major power companies, who had assumed that all energy would come from nuclear. However, the City of Gothenburg had maintained its focus on DH, which had at that time been made up of a series of islands powered by oil-fired generators. By 1980 the high price of oil and low electricity prices had undercut the CHP market, but instead of moving over the electrical heating Gothenburg had decided to exploit waste heat, energy from waste, heat pumps and sewage heat. This was the basis for uniting the various islands into a single network. Since then coal, oil and, increasingly, biofuels had been used.

Emissions had fallen as a result of these policies, enormously in the case of sulphur and NOx, in the case of CO_2, from 600,000 tonnes to 250,000 tonnes per annum. The goal was for DH to be wholly derived from waste heat, with zero primary fuel input. In summer there was excess heat production, but this could be used to produce cooling if required.

The Northern European electrical system was now very interconnected, with overall consumption rising (currently around 400 TWh per annum). The fuel mix was largely nuclear and hydro, though there were coal-fired generators in Denmark and Germany. Losses from the inefficiencies of this system were estimated at 200 TWh, compared with Sweden's total demand for heat of 100 TWh. There was thus an enormous resource being wasted, and one of the priorities should be to bring generating capacity closer to urban areas so that this resource could be exploited. He did not believe that nuclear power stations were needed in Sweden, as much of the electricity generated was currently used for electrical space heating.

Göteborg Energi was now investing in a gas-fired CCGT plant, which from an input of around 600 MW natural gas would generate electrical output of 270-300 MW and heat output of 230-250 MW. This would reduce dependence on the electricity grid, as well as reducing emissions emanating from coal-fired power stations in Denmark and Germany. In the short term the use of biomass fuel would be less environmentally friendly, as it would lead to a lower electrical output and continuing dependence on the grid. However, in the longer term natural gas was not a viable solution, and the development of gasification techniques to allow the use of biomass fuel in co-generation should be a priority. Natural gas should be seen as the bridge from the current fuel mix (coal, oil, nuclear) to a future reliance on biomass.

In terms of liberalisation, it had been the case that some decades ago DH contracts had tended to require customers to remove alternative sources of energy from properties. DH was now more open to competition, and while the sharing of individual DH networks did not offer any benefits, customers were free to turn to other local energy sources such as electricity.

Wednesday 2 February, Gothenburg; Meeting with Professor Thomas Kåberger

The Committee heard a presentation from Professor Thomas Kåberger of Chalmers University, regarding his evaluation of the Local Investment Programme (LIP).

The LIP had evolved in the late 1990s, as a means of encouraging investment in technologies contributing to sustainable development, particularly in the construction sector. The intention was to use Government investment to stimulate construction sector investment. The problem with the scheme was that the goals and responsibilities were more diverse than was normal for such Government schemes. It was also hard to evaluate results, and this had been the subject of his own research.

The total LIP budget over four years had been 6.2 billion SEK (approximately £500 million, or some £50 per head of population). The municipalities had been charged with developing local programmes, involving local interests and businesses. The objectives of such programmes had been broad—to increase employment and to build towards sustainability. Individual projects were to be non-profit-making and technologically novel. Some 55 percent of municipalities had received grants, representing in each case some 20-30 percent of project costs.

In terms of overall impact, projects completed hitherto had achieved a 10 percent reduction in CO_2 and SO_2 emissions, and a small (0.5 percent) reduction in NOx emissions, at a cost equivalent to approximately £10 per tonne CO_2. However, it was difficult to measure the efficiency of this investment, as there was no fixed cost attaching to carbon emissions. In terms of employment, projects had delivered jobs at a cost of approximately 284,000 SEK per man year, or 1.7 million SEK (about £130,000) for each permanent job.

Evaluating this impact had been challenging: there were seven environmental goals, and a range of different agencies and actors. The database of the Environment Agency had been used, and efficiency indicators calculated to quantify emissions reductions. Ten municipalities had been visited in order to assess reporting practices and the economic sustainability of investments. One project had been examined in detail. Professor Kåberger was confident that the analysis had tended to over-estimate the costs by ascribing total costs to specific reductions in CO_2. Indirect effects had been factored in. However, some municipalities had calculated the impact on electricity consumption by reference to the Nordic fuel mix, while others had calculated marginal savings from the closure of specific coal or gas-fired plant.

There seemed to be two main reasons for this very positive evaluation: successive selection and constructive evolution. Successive selection had been inherent in the process, whereby municipalities and the Environment Agency had at each stage rejected less valid proposals. Even once subsidies had been granted not all projects had been executed, as municipalities had not in every case made budgetary provision. As a result only the most worthwhile and best planned projects had been executed. Constructive evolution was the term given to the process whereby projects were modified and improved as they developed—there had been considerable flexibility in this regard, as long as subsidy levels were not increased.

The project that had been examined in detail concerned the pulp and paper industry. This involved finding a use for difficult biomass wastes, such as fibre sludge, to produce steam or heat. This would in fact have been profitable without subsidy, with a payback time of around four years.

In conclusion, despite its complexity, the LIP had been a successful and efficient use of public money. The key had been the stimulation of dialogue between municipalities and local industry.

Visit to Angered

The Committee, accompanied by Dr Henrikke Baumann of Chalmers University, was shown around the Angered housing development by the architect, Mr Christer Nordström. Angered was a late 1960s development of some 2,500 apartments in all, of which 250 had been covered by the project. It was wholly owned by the City of Gothenburg, and was one of the most deprived housing developments in Sweden. There was very high unemployment, a very high concentration of immigrants, and one third of flats were empty. The redevelopment project had thus been designed to improve not only the energy efficiency of the flats, but to contribute to social renewal.

The refurbishment had been funded by the EU Commission, and had cost about 5,300 SEK (around £400) per m^2—about a third the cost of a new building.

Very few of the residents paid rent, but the market rate would be of the order of 4,000-5,000 SEK (£300-380) per month, including heating and hot water. Heating was provided free up to a certain temperature—if residents wanted a higher temperature they paid. This meant that it was the responsibility of the landlord to maintain a proper temperature of around 20-21°C, and it was therefore in the landlord's interest to achieve energy efficiency savings.

Open passages at ground level, which had acted as wind tunnels, had been closed off, and were now occupied by laundries and communal greenhouses. Solar collectors on the roof provided hot water, which was stored in the basement, where the laundries had been formerly. Outside walls had insulated facades, which drew down the heat from the solar collectors. In addition, all roofs were insulated, and ventilation had been replaced by heat exchangers. Some windows had been changed in their entirety, others reglazed with heat-reflective panes—but all had been repainted and resealed. South-facing balconies were now glazed, allowing passive solar gain, and pre-heating the air for ventilation. This glazing could be opened up in summer, but could not be closed off to the outside air—the balconies were designed to be cold in winter, so as to discourage occupants from installing electric heaters and using them as sitting space.

The solar collectors provided around 30 percent of hot water and heating—the rest was topped up from the Gothenburg DH network. Demand had formerly been around 260 kWh/m^2, but had now fallen to 160 kWh/m^2. Electricity demand had fallen by 30 percent.

APPENDIX 9: VISIT TO THE FLAGSHIP HOME, KNIGHTSBRIDGE

8 February 2005

Members visiting the Flagship House were: Lord Broers, Earl of Lindsay, Lord Oxburgh, Baroness Perry of Southwark (Chairman), Baroness Sharp of Guildford, Lord Wade of Chorlton, Lord Young of Graffham. In attendance: Professor Roland Clift (Specialist Adviser), Dr Christopher Johnson (Clerk), Dr Jonathan Radcliffe (Specialist Assistant).

The Committee was welcomed by Matthew Knight of the Energy Saving Trust. Members toured the Home, a privately owned, nineteenth century terraced building located in a conservation area. When the refurbishment was complete it would contain nineteen flats, many of them bedsits. Each had a shower room, but lavatories were shared (the existence of shared facilities meant that the property qualified as a house in multiple occupation).

The bulk of funding for the refurbishment came from the developer, but the Royal Borough of Kensington and Chelsea had contributed £90,000 (a figure in line with normal grant funding for such projects) and the Energy Saving Trust had also contributed. Four of the units would be made available as "affordable housing" (i.e. at two thirds of normal market rent) for five years.

The building had been lined throughout with 35mm plaster-board to improve insulation. Double glazed sash windows had been fitted at the back of the property, but English Heritage had not allowed replacement of the windows at the front, so secondary glazing had been fitted instead. A timber-framed extension had been added at the top of the house, which would generate additional rental income. On the roof German-made solar collectors, installed at a cost of £20,000, would meet 50-60 percent of the building's hot water needs, and would be backed up by two condensing boilers. Dedicated fittings for low-energy lighting had been installed, and all appliances were A-rated. Ventilation was crucial: air from cooker extractor hoods (running constantly at low speed) would be filtered and passed through a heat exchanger in order to warm incoming air.

It was intended that the refurbishment would be a demonstration of the some of the options available for similar refurbishments. However, it was not expected that the entire project would be replicated. It was confirmed that the Council had made no calculation of the payback time on the various energy efficiency measures—this was a matter for the owner. However, as the building had been in a poor state, requiring complete refurbishment anyway, the additional marginal cost of the energy efficiency measures was relatively small. In use, residents would be metered and billed for electricity consumption; however, hot water and heating would be included in the rent.

APPENDIX 10: VISIT TO LEICESTER CITY COUNCIL

21 February 2005

Members visiting Leicester were: Lord Broers, Lord Lewis of Newnham, Lord Paul, Baroness Perry of Southwark (Chairman). In attendance: Professor Roland Clift (Specialist Adviser), Dr Christopher Johnson (Clerk), Dr Jonathan Radcliffe (Specialist Assistant).

The Committee was welcomed by Councillor Ross Willmott, Leader of Leicester City Council (LCC). He drew attention to the city's long-term, cross-party commitment to energy efficiency and the reduction of greenhouse gas emissions. In 1990 LCC had set a target of a 50 percent reduction in emissions by 2025. If such local initiatives were replicated across local government the effect on the UK overall would be dramatic.

One of the major initiatives being considered at present was the establishment of an energy services company, to create an "energy highway". Although there was some support from the EU for this initiative, it would be helpful if the Government could give more support by allowing local authorities to run local utilities.

Mr Don Lack, Head of Service, Energy Management, presented an overview of LCC's policies. The city had a considerable legacy of mature housing, but LCC had attempted to set an example by making council premises, including the City Rooms, as energy efficient as possible. Solar energy was used to power meters etc. However, a key role was placed by information gathering, notably the collection of data on energy consumption at seven strategic points around the city and fed into a single computer system. These data, based on real-time, half-hourly metering of energy and water consumption, allowed the establishment of parameters of normal usage. Databird software identified aberrations or variations and set off alarms, which were checked and acted upon daily. Data were collected from public buildings, but the Council also provided a similar service to a number of SMEs.

An extension of information use was the installation of information panels within buildings, providing real-time information for occupants on energy use, carbon emissions, etc. LCC had also engaged with the EU Display Project in developing an "energy label" for display in public buildings. The Leicester Energy Centre had been developed to offer free and impartial advice to local people, who could also buy a range of energy efficient equipment, change energy suppliers, and so on.

LCC had also developed a "solar rental" project, inspecting homes and identifying the scope for improvements in energy efficiency. Once efficiency levels had been raised, occupants were able to rent solar panels to provide hot water—the rental cost being offset against savings in gas and electricity bills.

Leicester's district heating system dated back to 1953, and the infrastructure was not visible above ground. If provided heat for around 4,000 dwellings. Heat was generated by a gas-fired CHP plant—although the Council was planning to install a biomass generator, fuelled by locally sourced natural wood, there were difficulties securing funding from East Midlands Development Agency. The advantage of district heating was the durability of the infrastructure—though initially expensive, it lasted 35-50 years. This meant that improvements in generating technology could simply be slotted in, benefiting all the properties connected to the system.

The key lessons of experiences in Leicester were: the importance of real data on energy use; knowledge of and participation in EU developments; good media relations; the readiness of local authorities to take risks; and the commitment of time, effort and funds. Efforts were hampered by the lack of clarity in legislation and the lack of an overall, joined-up policy.

Ms Carol Brass (Team Leader, Environment Team), set the strategic context: Leicester's Climate Change Strategy dated back to 1990, and was owned by the entire Leicester Partnership. This was backed up by a Leicester Environment Strategy, which covered such issues as water use. In addition to the 2025 target of a 50 percent reduction in greenhouse gas emissions, the city had a ten percent target for energy from renewables (including heat as well as electricity), as well as targets for reducing fuel poverty.

There was a longer-term "EMAS" (European Eco-Management Audit Scheme) target. The main problem at present was in the transport sector, but some 20 schools were currently registered with EMAS, and more than half would be registered by 2007. This demonstrated the Council's commitment to improving environmental awareness within the education system.

There was also a "Keep Leicester Cool" campaign, focused on ethnic minorities, who had not engaged with earlier campaigns; and an awards scheme. There was a partnership with a local newspaper, which badged energy stories under the heading "Our Environment Our Future".

The Committee then visited the Energy Centre, before hearing a presentation from Mr Prakash Patel on LCC's metering system. This was made up of three elements: the meters themselves; the Databird logging software; and radio antennae communicating information between sites. Data were automatically analysed to identify exceptions to normal patterns of use. The key benefits were the timely and accurate management of information; instant access to meters, however inaccessible; rapid identification of problems; the capacity to customise information so as to help establish good housekeeping; benchmarking; the ability to generate internal league tables. The system was capable of factoring in weather conditions in establishing the parameters of normal usage.

The system had cost £500,000 (compared with LCC's total budget for energy and water of £5 million). Savings of £160,000 per annum had been identified, of which some £60,000-70,000 had been realised. This produced an acceptable payback time, within the Save to Spend rules. The overall message was, "If you can't measure it, you can't manage it".

The Committee then visited the Queen's Building, and discussed research projects at the Institute of Energy and Sustainable Development with Professor Paul Fleming. He noted that the Institute's work programme was increasing making use of psychology and economics, in addition to traditional "hard" science.

The Committee also visited the Leicester Eco House and the Six Street Solar Roof Project. It was noted that with regard to the Six Street project, that solar PV had been chosen ahead of solar thermal in large part because of the availability of grants. In addition, the occupants had been able to benefit from a net metering arrangement, agreed by the supplier Ecotricity. The Committee finally visited Eyres Monsall School, where a 2.5 kW wind turbine, the first in Leicester, had been installed in December 2004. This initiative had been decided by the pupils themselves, and broke new ground in planning terms. Other schools were following suit, planning larger, 5 kW turbines.

APPENDIX 11: VISIT TO DURHAM UNIVERSITY

4 April 2005

Sub-Committee II visited the University of Durham to look into the challenge of achieving energy efficiency in a historically sensitive and fragmented estate. Members attending were: Lord Lewis, Lord Paul, Baroness Perry (Chairman) and Baroness Sharp. In attendance: Dr Christopher Johnson (Clerk) and Dr Jonathan Radcliffe (Specialist Assistant).

Sir Kenneth Calman, Vice-Chancellor, welcomed Members to the University of Durham. Peter Robinson, Director of Estates and Buildings, and Dave McCaffery, Engineering Services Manager, gave a presentation to the Sub-Committee, followed by a tour of parts of the University, including Durham Castle, Palace Green Library and Hatfield College. During the day, significant points raised included:

The University Estate was spread over 212 hectares, consisting of 217 buildings built between 1076 and 2004, with Durham Castle designated as a World Heritage Site. The large size and the fragmented and historical nature of the estate imposed limitations on the energy efficiency measures that could be implemented. They also meant that the task of upkeep was hugely expensive—the total cost of the Estates backlog maintenance was estimated at over £80 million.

The University's efforts to improve energy efficiency had largely been pursued in isolation. If anything, the attitude of the Local Authority and other agencies had been unhelpful. The Local Planning Authority and English Heritage had imposed severe restrictions on changes that could be made to some historic buildings to increase their energy efficiency. Secondary glazing has not been permitted as it would alter the external appearance. There had also been objections to the installation of roof insulation in some areas, although in less sensitive areas it had, where possible, been applied. In addition, the Sub-Committee was told that the Heritage Lottery Fund would not support refurbishment of the Castle, on the basis that the building was used for student accommodation.

The district heating scheme, which dated from the 1950s and 1960s and served buildings on the Peninsula, was being decommissioned due to high running and maintenance costs. The high cost of laying modern pipe work to carry hot water, and the very limited demand for heat within the confines of the Peninsula, had ruled out a new district heating or combined heat and power scheme. Instead, high efficiency gas boilers were being installed locally.

The Estates and Buildings Department of the University had introduced an energy efficiency improvement plan. An energy management system was used to monitor electricity and gas consumption, with most buildings covered by a sub-meter. Case studies showed significantly reduced energy use and costs. For example, the regulation of fans drawing gases from fume cupboards in the Chemistry Building had saved £6,000 a year, with a payback period of 10 months; the upgrade and improvement to the lighting system in the Main Library Building had a projected annual saving of £24,000 and a three-year payback period.

The University, with energy costs of £3.5 million, had made budget provision (subject to approval) to employ a dedicated Energy Manager. The Engineering Services Manager, currently responsible for energy, could only dedicate about 20 percent of his time to these matters.

APPENDIX 12: ACRONYMS AND GLOSSARY

Acronyms

ACE	Association for the Conservation of Energy
Alfed	Aluminium Federation
BCA	British Cement Association
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
CBI	Confederation of British Industry
CCA	Climate Change Agreement
CCGT	Combined cycle gas turbine
CCL	Climate Change Levy
CEP	Community Energy Programme
CHP	Combined heat and power
CIGA	Cavity Insulation Guarantee Agency
CO_2	Carbon dioxide
dCHP	Domestic combined heat and power
Defra	Department for the Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
DTQ	Domestic Tradable Quota
DUKES	Digest of United Kingdom Energy Statistics
EAPG	Energy Advice Providers Group
ECA	Enhanced Capital Allowances
ECI	Environmental Change Institute
EEC	Energy Efficiency Commitment
EIC	Environmental Industries Commission
EPBD	Energy Performance of Buildings Directive
EPSRC	Engineering and Physical Sciences Research Council
ESCO	Energy Service Company
ESRC	Economic and Social Research Council
EST	Energy Saving Trust
ETS	Emissions Trading Scheme
GW	Gigawatt (1,000,000,000 watts)—see below
GWh	Gigawatt hour
HBF	House Builders Federation

IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
Ktoe	Kilotonnes (1,000 tonnes) oil equivalent
kW	Kilowatt (1,000 watts)—see below
kWh	Kilowatt hour
LGA	Local Government Association
MMC	Modern Methods of Construction
MtC	Megatonnes carbon
Mtoe	Megatonnes (1,000,000 tonnes) oil equivalent
MTP	Market Transformation Programme
MW	Megawatt (1,000,000 watts)—see below
MWh	Megawatt hour
NAP	National Allocation Plan
NERC	Natural Environment Research Council
NETA	New Electricity Trading Arrangements
NIA	National Insulation Association
ODPM	Office of the Deputy Prime Minister
Ofgem	Office of Gas and Electricity Markets
PIU	Performance and innovation unit
POST	Parliamentary Office of Science and Technology
R&D	Research and Development
RCEP	Royal Commission on Environmental Pollution
RCUK	Research Councils UK
RSPB	Royal Society for the Protection of Birds
SEPN	Sustainable Energy Policy Network
tC	tonnes carbon
TW	Terawatt (1,000,000,000,000 watts)—see below
TWh	Terawatt hour
UKERC	United Kingdom Energy Research Centre
U-value	Measure of the amount of heat transferred through one square metre of a given material, given a temperature differential of one degree Kelvin, expressed in watts per square metre per degree difference (W/m^2K)

Glossary

Units of energy

Various units are used to quantify energy. For example, the Digest of UK Energy Statistics uses tonnes oil equivalent (toe). In this report energy is quantified in terms of watt-hours (Wh) and, in the case of Dr Sinclair's paper, joules (J).

A joule is a measure of total energy used, equal to the work done when a force of one newton acts through a distance of one metre.

A watt is a measure of the rate of use, or generation, of energy (not just electricity), equal to one joule per second. If follows that a watt-hour is a measure of the total amount of energy used, or generated, over time—one watt-hour being equal to 3,600 joules, one kWh equal to 3.6 MJ. A 100 W light bulb left on for two hours will consume 200 Wh of energy, or 720,000 joules (0.72 MJ).

One tonne of oil equivalent, equivalent to 7.4 barrels of crude oil in primary energy, is approximately equal to 42 GJ (42 billion joules), or 11.7 MWh.

The abbreviations k, M, G or T preceding Wh or J indicate increasing amounts:

- k (kilo): thousands (1,000 or 10^3)
- M (mega): millions (1,000,000 or 10^6)
- G (giga): billions (1,000,000,000 or 10^9)
- T (tera): million-millions (1,000,000,000,000 or 10^{12})
- P (peta): thousand-million-millions (1,000,000,000,000,000 or 10^{15})

Carbon units and emissions

Emissions to the atmosphere of greenhouse gases are by convention quoted in terms of the carbon (C) equivalent amount, as carbon dioxide (CO_2) is the principal greenhouse gas occurring as a by-product of burning fossil fuels. Amounts are often described in millions of tonnes (Mt) of carbon, MtC. Occasionally, however, emissions are expressed in terms of CO_2 equivalence (for instance, in Dr Sinclair's appendix to this report). The relative atomic weight of the carbon and oxygen atoms contained in each molecule of CO_2 (12:32) means that 1 tonne of CO_2 is equivalent to 0.273 tonnes carbon.

When calculating emissions amounts of other greenhouse gases are multiplied by a factor, called the Global Warming Potential (GWP), that approximates their time-integrated warming effect in the atmosphere, relative to CO_2. Considering a time horizon of 100 years (the period used when calculating national greenhouse gas inventories), methane (CH_4) has a GWP of about 24 times that of CO_2, nitrous oxide (N_2O) has a GWP of some 320.

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