

Energy Efficiency Strategy

1. Introduction

1.1 Improving energy efficiency will be one of the major challenges in moving towards delivering energy policy objectives. Energy efficiency lowers energy bills and, where cost effective, it contributes to business competitiveness. In low income households, it helps people keep warm. However, this is not the only reason for paying particular attention to energy efficiency. Reductions in energy use can assist energy security objectives. And the majority of the energy used in the UK is derived from fossil fuels, and therefore contributes directly to climate change. Work elsewhere in the Energy Review indicates that future climate change policy will impose significant constraints on UK energy use. Improving energy efficiency is therefore a priority.

1.2 Energy efficiency already forms a major part of the Government's Climate Change Programme. There is a large potential for investment that has both economic and environmental benefits. The challenge for Government policy is to improve energy efficiency in such a way as to maximise these synergies, whilst minimising trade-offs with other Government goals. Policy to 2010 needs both:

- increase energy efficiency activity that is already cost effective, and
- encourage energy efficiency innovation as part of the route to a sustainable energy economy in the longer term.

1.3 This paper outlines this challenge over the period to 2010. It concentrates on the short-term agenda. Analysis and policy recommendations for the longer term will be considered in ongoing work in the Energy Review. The paper demonstrates how energy efficiency can be improved, whilst meeting wider objectives by delivering other environmental improvements, improving economic performance and minimising adverse effects in specific regions, sectors and firms. It addresses energy efficiency in two of the three main energy consuming sectors: households, business (industry, commerce and public services). Preliminary estimates are given for the scope for transport energy efficiency, but transport energy efficiency policy options will be addressed elsewhere in the Review. The paper sets out:

- the technical and economic potential for improved energy efficiency by 2010,
- why most households and businesses do not at present use the cost-effective opportunities available to them – the barriers to energy efficiency,
- the benefits of innovation for energy efficiency,
- the principles for consideration in energy efficiency policies, and
- some specific proposals for policy.

The analysis of the potential for energy efficiency improvement relates to the UK as a whole. The policy options identified are for England only, as energy efficiency policy is devolved issue in Scotland, Wales and Northern Ireland.

2. The Current Potential for Energy Efficiency

2.1 The efficient use of energy is defined as maximising the energy services (warmth, illumination, mobility etc.) obtained from any given amount of energy. In more familiar terms, it is about reducing energy waste. Energy is wasted at various points in the 'energy chain' that delivers energy from the point the resource is exploited through to the services it provides. The most important sources of waste are, in declining order:

- the point of end use in homes, businesses and vehicles, where energy is converted into the services we want,
- energy conversion processes in the energy industries, in particular the production of electricity, and
- energy transportation, especially the electricity transmission and distribution networks.

2.2 This paper addresses energy efficiency at the point of end use, often known as the demand side. This includes the scope for improving energy efficiency by generating power where there is a heat load (combined heat and power, CHP). The scope for improving energy efficiency in other parts of the energy chain is dealt with elsewhere in the Review.

2.3 The potential for improving energy efficiency may be described in several ways (see Glossary in Annex 1). The theoretical scope for improvement (the thermodynamic potential) is very large. In energy conversion alone (at the point of end use and in the energy industries) it is more than 50%¹. When the scope for reduction by improved management, control and insulation is also included we estimate we could theoretically get our current level of energy services using just 20% of the energy used now. This emphasises the potential of innovation in energy efficiency.

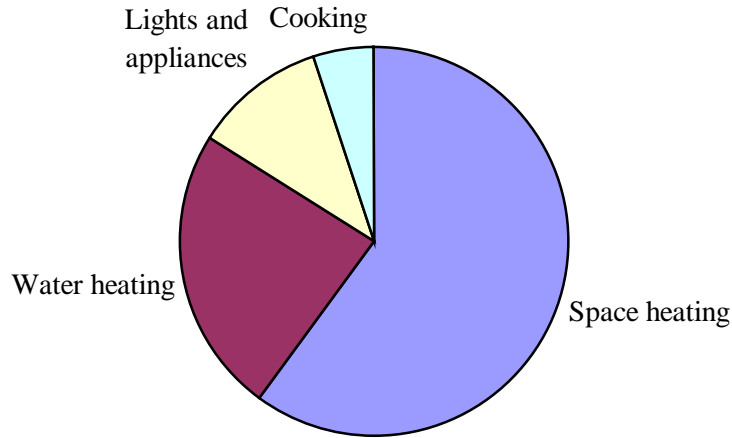
2.4 Of course, what can be achieved economically with our current technology is much less. The broad potential is addressed below separately for each of the major demand side sectors.

The Domestic Sector

2.5 Energy use in the domestic sector (excluding transport) is 47 Mtoe/year accounting for 27% of the total in the UK, contributing approximately 40 MtC (26 %) of total UK carbon dioxide emissions. The breakdown is shown in Figure 1. Space and water heating together use more than 80% of energy. Lights and appliances are responsible for only 11%, but a much larger share of carbon emissions.

¹ Based on Exergy Analysis of the UK energy system. Hammond, G.P. and Stapleton, A.J. Proc IMechE 215 A 141-162.

Figure 1
Domestic Sector Energy Use



Box 1

Tackling Fuel Poverty

Fuel poverty is defined as the inability to afford adequate warmth and other energy services for 10% of household income. In particular, it affects low-income households living, in some cases, in older, ‘hard to heat’, homes.

Tackling fuel poverty requires joined-up action across many agencies and businesses.² Social security, housing and energy pricing policies have a role to play, but improved energy efficiency is a key component. The government is consulting on proposals to eliminate fuel poverty in vulnerable households by 2010, largely by improving the energy efficiency of the relevant homes. The large number of households in fuel poverty is a key reason why Government has pursued low fuel prices and, to date, not used fuel or carbon taxes for household energy use.

Traditionally Government and other programmes to tackle fuel poverty have concentrated largely on insulation of lofts, pipes and cavity walls. Efficient heating systems are now included. Our analysis indicates that, to achieve Government fuel poverty objectives, energy efficiency programmes will also need to include more measures in solid wall properties. These are the most expensive to heat, but also the most costly to insulate.

² UK Fuel Poverty Strategy – Consultation Draft. DETR, May 2001.

2.6 The energy efficiency of new homes has improved significantly over the last thirty years. The planned changes to the Building Regulations will further improve performance. In the longer term, building homes with no significant space heating requirements is a realistic goal. However, the stock of homes changes very slowly. Improving the efficiency of the existing stock is therefore critical in the medium term.

Table 1
Energy Savings and Emissions Reduction from Domestic Energy Efficiency

Measure	Mtoe	MtC	Internal Rate of Return
<i>Economic Potential</i>			
Loft insulation	1.7	1.4	16%
Cavity wall insulation	3.2	2.6	32%
Hot water cylinder insulation	0.4	0.3	200%
Condensing boilers ^a	6.5	5.3	27%
Energy efficient lighting	0.9	1.4	50%
Energy efficient appliances.	1.9	2.9	19%
Double glazing ^a	2.1	1.7	19%
Heating controls	0.5	0.4	38%
Small-scale CHP	0.2 ^b	0.3	19%
Sub-Total (Economic potential)	17.4^c	16.3	
<i>Percentage of domestic total</i>	<i>37%</i>	<i>41%</i>	
<i>Additional technical potential</i>			
New district heating CHP	0.6 ^b	0.9	
Solid wall insulation	3.4	2.8	3%
Draught proofing	0.4	0.3	6%
Solar water heating	2.0	1.6	-8%
Ground source heat pumps	0.4	0.7	0%
High performance glazing	1.5	1.2	-2%
Sub-total	8.3^c	7.7	
Total	26.01^c	23.8	
<i>Percentage of domestic total</i>	<i>54%</i>	<i>57%</i>	

- a. Economic only at the end of existing product normal life
- b. CHP savings are primarily in reducing demand for central electricity generation
- c. Totals should be treated with care, as there may be some double-counting

2.7 Estimates of the current technical potential and corresponding reduced carbon emissions for improvements to the domestic housing stock are shown in Table 1³. There

³ Based on Fisher, J. et al, Prospects for Energy Saving and Reducing Demand for Energy in the UK, 1998 (ref 5); 'Innovative Energy Efficiency Technologies for UK Housing', NES 1999; 'Energy Efficiency and Environmental Benefits to 2010', Energy Saving Trust 1997; Market Transformation Programme, 2001;. 'A realistic strategy for reducing greenhouse gas emissions in the period 2000-2010 using improvements in energy end-use efficiency', ACE 1997.

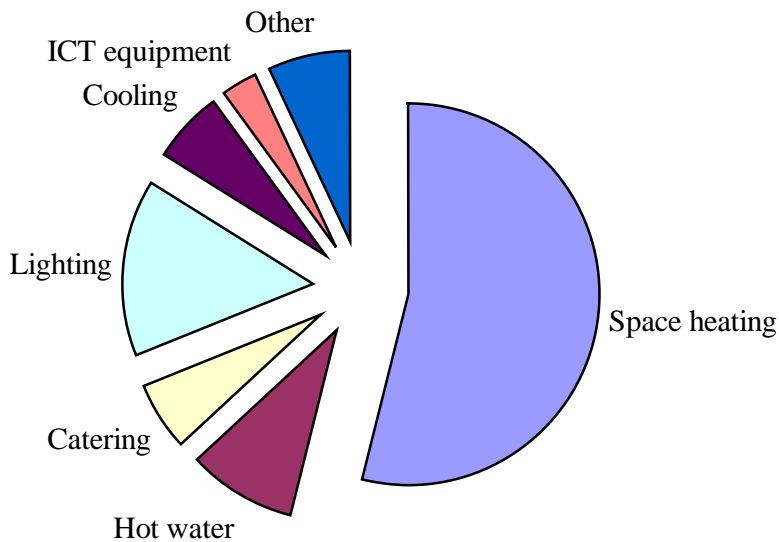
is inevitably some uncertainty about costs and potential – the numbers in Table 1 represent our best estimates. The total is equivalent to more than 50% of domestic energy use and emissions. It excludes any contribution from micro-CHP – a technology that is under development, but not yet demonstrated.

2.8 Even at current prices, the economic potential is approximately 40%, reducing emissions by a similar amount. The fraction that can be achieved by 2010 is constrained by stock turnover, installer capacity and householder attitudes. Taking account these factors, there is broad agreement that overall savings of about 5MtC are achievable in the domestic sector by 2010 by expansion of current programmes. This is reflected in the UK Climate Change Programme.

The Service Sector (Commercial and Public Buildings)

2.9 Energy use in the service sector is 18 Mtoe in 2000 leading to emissions of approximately 19 MtC. The breakdown by end use is shown in Figure 2.

**Figure 2
Energy use in the Service Sector⁴**



2.10 There has been significant growth in energy use over the last decade, especially in offices. With continued sector growth and no additional energy efficiency measures beyond business as usual, energy use would be expected to increase by 7% between 2000

⁴ Based on 1994 data, Department of Trade and Industry, Energy Paper 66.

and 2010⁵. The current technical potential for energy efficiency is estimated to be 39%⁶. This excludes new technologies that may become available before 2010. The current economic potential is estimated to be 21%. About half of this could be achieved by 2010.

2.11 The technologies for improving insulation and heating systems are similar to those in the domestic sector. Lighting is relatively of more importance. Air conditioning and office equipment both make a growing contribution to energy use, and therefore efficient technologies will be increasingly important. CHP currently makes only a small contribution, but small-scale systems have considerable potential.

Industrial Sector

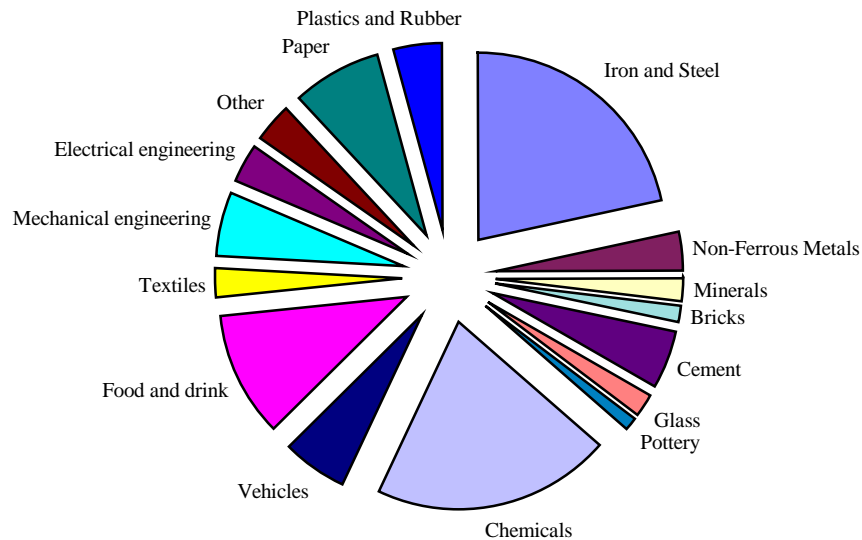
2.12 Industry makes a falling, but still significant, contribution to energy use (36 Mtoe in 2000) and carbon dioxide emissions. Many sub-sectors contribute significantly to energy demand and emissions. Some, like steel and chemicals, are particularly large energy users, but significant energy efficiency gains will depend on action across many sectors. See Figure 3 and Table 2 .

Table 2
End Use Applications of Energy in Industry (1995)

End use	Energy use (Mtoe/year)		
	Fossil fuels	Electricity	Energy
High temperature processes	11.2	0.8	12.0
Low temperature processes	7.9	0.6	8.5
Space heating and lighting	4.9	0.7	5.6
Motors and drives	0	4.7	4.7
Drying	2.7	0	2.7
Compressed Air	0	0.5	0.5
Refrigeration	0	0.5	0.5
Total	26.7	7.8	34.5

⁵ Department of Trade and Industry. Energy projections for the United Kingdom. Energy Paper 68.

⁶ Fisher, J. et al, Prospects for Energy Saving and Reducing Demand for Energy in the UK, 1998. <http://www.rcep.org.uk/studies/energy/98-6063/fisher.html>



Industrial Energy Use by Sector, 2000

Figure 3

2.13 Major improvements in energy productivity have been achieved since 1970⁷, although the rate of improvement has slowed in recent years. Energy productivity has been improved by the shift in UK economic activity away from heavy industry. We expect that this trend will continue as knowledge-based activities play a larger role in economic activity in relation to energy-intensive industries. But most of the historical effect is improved energy efficiency within individual sub-sectors. Increases in energy prices in the 1970s played a major role, which persisted into the 1980s, as there tends to be a lag between price changes and efficiency improvements.

2.14 Steam, space heating and motive power efficiency improvements offer the largest scope in the short-term for energy efficiency improvement. In the longer term, there may be more scope for changes in process energy use through process and product change. The scope for improving energy use in manufacturing industry by 2010 using current technologies is significant. It is estimated that the technical potential is more than 30% above business as usual and the economic potential 20%⁸. More details are given in Table 3.

2.15 A major contributor to the potential is CHP production on site, with the heat used for industrial processes. CHP can achieve overall efficiencies of greater than 80%, and therefore is far more efficient than the alternative option of using boilers for heat production with electricity bought in from power plant that operate at efficiencies of 50% or lower. Current CHP capacity is approximately 4300 MW, producing 20 TWh/year. The economic potential for CHP is estimated to be in the range 12,000 to 20,000 MW⁹.

⁷ see Department of Trade and Industry. Energy Consumption in the UK. Energy Paper 66.

⁸ Fisher, J. et al, Prospects for Energy Saving and Reducing Demand for Energy in the UK, 1998. <http://www.rcep.org.uk/studies/energy/98-6063/fisher.html>

⁹ DEFRA. Draft CHP Strategy. Forthcoming.

**Table 3
Energy Efficiency Potential by Industrial Sector**

Sector	Energy Efficiency Potential to 2010 (in Mtoe)	
	Economic	Technical
Metals	2.2	3.2
Minerals and Ceramics	1.3	1.8
Chemicals	1.1	1.9
Food & Drink	0.7	0.8
Paper and Textiles	1.4	2.4
Engineering and Other	1.9	3.3
Total	8.6	13.2
Percentage	24%	36%

2.15a More detailed work on transport will be undertaken elsewhere in the Energy Review. Our preliminary estimate is that the cost effective potential for energy efficiency improvement (excluding modal switching) is currently approximately 35%.

Summary of Current Potential

2.16 The current cost effective potential for energy efficiency in all sectors is summarised in Table 4. It amounts to approximately 30% of final energy demand. The potential financial benefits in reduced costs to consumers (net of taxes) are £12 billion annually.

**Table 4
Summary of Current Economic Potential for Energy Saving**

Estimated Potential for Currently Economic Savings			
Sector	Energy (Mtoe/year)	Percent	Financial (£M)
Domestic	17.4	37.2%	5006
Service	3.8	21.0%	1193
Industry	8.6	23.8%	1378
Transport	19.3	35.0%	4701
Total	49.1	31.4%	12277

2.17 This is a very significant potential. The extent to which all of this potential is cost effective is still disputed. However, there is a consensus on the broad conclusion that much of it is, both from empirical work on existing programmes and studies of future potential, as well as amongst the stakeholders that we have consulted. It is broadly

consistent with estimates for other countries summarised by the Intergovernmental Panel on Climate Change¹⁰.

2.18 Historical empirical evidence for cost effective energy efficiency is from reliable sources. In the domestic sector, the National Audit Office has confirmed that existing regulatory programmes are highly cost effective¹¹. They save electricity at 22% of the purchase price (and less than half the avoidable cost of supply). In the business sectors, the investments stimulated by the Energy Efficiency Best Practice Programme are now estimated to save over £800 million annually, with a typical payback period of 2 to 4 years.

2.19 Studies by and for Government form the basis of the future energy efficiency programmes that are central to the UK Climate Change Programme – both the Energy Efficiency Commitments in the domestic sector and the Climate Change Negotiated Agreements in industry.

2.20 This scope for significant economic benefits is an important conclusion of our work. It is widely understood that improving energy efficiency can assist in delivering environmental and energy security objectives. But it is not the ‘hair shirt’ agenda some people still envisage. The large potential for cost effective investment makes improving energy efficiency a key part of the economic and social dimensions of energy policy as well. And, in the longer term, it is part of the agenda for an efficient, innovative and sustainable energy system. This will be addressed further in the Energy review in work on 2050 energy systems.

3. Demand Side Market Failure – A Key Issue

3.1 The identification of a significant cost effective potential for energy efficiency is important for analysis and policy in this field. Economic theory points to two explanations for measures identified as cost effective not being adopted. Either:

- not all the costs have been identified, and/or
- there is some form of market failure.

3.2 There may be some ‘hidden’ costs not fully accounted for in the calculations reported in Section 2. The most likely are transaction costs such as management time. However, many businesses and public sector organisations have shown that the employment of specialist energy managers is highly costs effective; the energy savings far outweigh the management costs. And the latter costs are not irreducible. The thrust of Government funded programmes, such the Energy Efficiency Best Practice Programme is to reduce these costs through targeted information. Similarly regulatory policies such as minimum

¹⁰ Inter-Governmental Panel on Climate Change. Working Group III Contribution to the Third Assessment Report. <http://www.ipcc.ch>

¹¹ The Office of Electricity Regulation: Improving Energy Efficiency Financed by a Charge on Customers. Report by the Comptroller and Auditor General. HC 1006 1997/98

standards and the Energy Efficiency Commitments greatly reduce the costs to households of eliminating inefficiency. In the latter case, for example, programme management costs add less than 20%, typically raising the cost of saving electricity from 22% of the purchase price to 28% of it.¹² Government action to change market structures can therefore reduce transaction costs and improve cost effectiveness. Other 'hidden' costs have been proposed, but none can explain away the very large identified potential for energy efficiency.

3.3 There is some indication that energy efficiency investment may sometimes not be undertaken because of perceived economic risks, including that energy prices may fall.¹³ To the extent that these risks are real, this is not a market failure – decision makers are keeping future options open. Risks of future energy prices fall into this category. This is likely to be particularly important for CHP, where cost effectiveness can be sensitive to the gas/electricity fuel price differential. However, where prices do not include externalities, Government may be able to address the barrier through action on the external cost market failure. Markets, on their own, will not take care of environmental costs. Where perceptions are based on imperfect information, e.g. that a reliable technology is unreliable, they constitute market failure.

3.4 Both hidden costs and risk reduce the economic potential below that indicated above. But neither explains failure in well-proven, clearly economic options. Our conclusion is that energy efficiency markets are imperfect. Saving energy is, in many cases, significantly cheaper than supplying it, but the market does not deliver the most economically efficient outcome. The exact nature of the market failure can be debated, but its existence is demonstrated by this inefficiency.

3.5 The textbook economic model of well functioning market is therefore an imperfect description of the way that real energy use markets operate in practice. Many of the usual conditions for a perfect market are not fulfilled in energy efficiency markets (see Box 2). This is why investment in energy efficiency falls well below the levels that would optimise economic efficiency.

3.6 The scale of the energy efficiency benefits possible (£12 billion) provides a *prima facie* case for Government to intervene in the market, especially taking into account the additional environmental and energy security benefits provided by energy efficiency. Where a barrier is a market failure, successful intervention might be expected to contribute to all key energy policy objectives – economic, environmental and security. In other cases, there may not be economic benefits and the case for intervention needs to be carefully examined.

3.7 However, the existence of market failure, in itself, provides little indication of the best response for Government. Of the barriers listed in Box 2 only the fiscal inequities and environmental externalities lend themselves to correction through energy pricing.

¹² op cit. reference 11

¹³ se e.g. Jaffe, A.B. and Stavins, R.N. (1994) The energy efficiency gap: what does it mean? *Energy Policy* 22 (10) 804-811.

Increased prices might also increase the demand for information. The remainder are more rooted in the structure of the market.

Box 2

Market Failure and the Barriers to Energy Efficiency

The barriers to investment in improved energy efficiency may be described in a variety of ways, largely depending in the disciplinary background of the analyst. In neo-classical economic theory many are market failures. The following may be identified.

- Most energy consumers have very imperfect information about energy efficiency opportunities and, especially in the domestic sector may distrust information from vested interests;
- Current market structures often require energy users to expend time and money to gather and assess information that is already available to suppliers;
- Better information on capital costs than running costs leads to adverse selection of inefficient goods;
- Capital markets are incomplete for many borrowers, for example low income households cannot borrow even for very cost effective projects;
- Inadequate contractual relationships with builders and other traders result in ‘moral hazard’ in sub-optimal specifications and the risk that that projects may not be implemented correctly;
- Tenancy contracts and rental values provide split incentives for energy efficiency investment in rented properties;
- Household investment in energy efficiency has less beneficial fiscal treatment than corporate investment in energy supply, as taxation is based on income rather than profits;
- Regulatory structures preclude potentially beneficial long-term contracts between licensed energy suppliers and domestic customers;
- The price of energy, in most cases, fails to take into account the environmental costs associated with its supply and use, i.e. there are externalities.

3.8 Understanding the best policy options for improving the efficiency of energy use markets requires a deeper understanding of the underlying causes of these market imperfections. There is an extensive academic literature covering institutional economics, management science, social psychology, sociology and political science. We have reviewed this as well as undertaking discussions with a broad range of stakeholders involved in energy efficiency. The results are described in Annex 2 and in our working papers¹⁴.

3.9 There is a broad consensus amongst energy efficiency analysts and professionals on the key problem. It can be best be described as follows. *Energy users, in both*

¹⁴ Chapman, J, and Eyre, N. Energy productivity to 2010 – Potential and Key Issues. (Summary is on the PIU web site www.cabinet-office.gov.uk/innovation)

*households and most businesses do not seek to optimise the economic efficiency with which they use energy. In a complex world, people have many concerns and most have a higher priority than energy efficiency. So projects that are primarily about energy efficiency are often not even considered. And in investment decisions and purchases that involve energy use, energy efficiency is usually a minor consideration*¹⁵. This underpins and reinforces the other barriers.

3.10 There are some important exceptions. A few industrial energy users are very energy intensive. In these businesses, energy efficiency is critical and taken very seriously. In a wider range of businesses, but still a minority, energy efficiency improvements offer substantial improvements to profitability. And in fuel poor households, energy costs are a large part of disposable income, so that improved energy efficiency can provide major economic, comfort and health benefits. But, in the vast majority of business and households, energy bills are a minor concern. They average 3% in households and 1.3% in businesses. Even quite substantial price rises would not make energy costs a major issue for most energy users.

3.11 It is clearly impractical for Government to seek to re-order the priorities of every energy user. The principal barrier to energy efficiency is therefore not easily open to 'correction'. Making energy use markets 'perfect' is therefore not a sensible goal. But this is not a case for inaction. The economic inefficiencies are large and a large number of policy interventions may improve them, even if they do not remove them. In the language of neo-classical economic theory, the policy options are 'second best', but they can still be a great deal better than no action at all.

3.12 Practical policies need to 'work with the grain' of real decision-making. They need to break through the barriers of motivation and bounded rationality. Section 5 discusses how policies to achieve this might be structured.

4. Looking to the Future - Innovation and Energy Efficiency

Why does innovation matter?

4.1 The technical and economic potentials for energy efficiency outlined in the Section 2 are a snapshot taken at the current time. The potential is not fixed. Because the thermodynamic potential for energy efficiency is very large, innovation can increase the potential substantially.

4.2 This is what has happened over recent decades. Innovation has increased the potential for energy efficiency at about the same rate that cost effective measures have been adopted. The result is that the 'current cost effective potential' has remained largely unchanged, even though energy efficiency in the UK economy has increased substantially. *Over the period since 1970, improved energy productivity has contributed*

¹⁵ The practice of limiting the number of issues that are considered in making a decision is commonly referred to as 'bounded rationality'

twice as much as changes in the energy supply mix to reductions in carbon emissions without 'using up' the potential for further progress.

Technological Change

4.3 Most of the potential for future advance in energy efficiency will rely on technological improvements in materials technology, design and control. These are the types of change where the pace may accelerate in the knowledge economy¹⁶. Energy efficiency is therefore expected to be an integral part of economic modernisation.

4.4 In the buildings sectors the slow turnover of the stock prevents very rapid improvements. Even if the scope for currently cost effective technology is exploited over the next decade, new technologies will continue to add to the technical and economic potential. These include new construction techniques, micro-CHP, heat pumps, super-insulating windows and high efficiency appliances. Design improvements to use solar energy for heating, cooling and lighting could also be significant.

4.5 In the industrial sector, significant improvements have been made in recent years in energy efficiency, especially since the first oil crisis of 1973. But a very large potential remains, especially through more fundamental changes to products and processes. Technologies that are already known but currently not widely used include membrane and crystallisation separation, process intensification, advanced refrigerants, absorption heat pumps, high temperature CHP and advanced motor controls¹⁷. And technologies that might be in common usage by the middle of the century may yet to be discovered.

4.6 In the transport sector, a very large potential lies in fundamental redesign of the car. Electric traction based on hybrid technology is entering commercial production. Fuel cell technology is the focus of major R&D programmes. Both offers large 'well to wheel' efficiency improvements. With advanced control technology and some battery storage they also potentially facilitate a number of other improvements including braking energy recovery, individual wheel control and engine capacity reduction. Combined with lightweight materials and aerodynamic design improvements, these can yield major efficiency improvements. Vehicles with fuel consumption of 3.4 litres/100 km (83 mpg) are already on the road. Design concepts could deliver 2.5 l/100km or less.

Market Change

4.7 Energy efficiency innovation needs to be understood more broadly than change in the technologies used at the point of demand. Broader social and institutional change may be just as important and liberalised energy markets may be a driver of change. To date the focus in supply markets has been on competition on commodity price. But as the scope for further reduction in supply costs falls, suppliers may increasingly look to market innovation and a wider package of products. In this context, there is the prospect for

¹⁶ E-topia? Contextual Scenarios for Digital Futures. Science Policy Research Unit, University of Sussex.

¹⁷ Energy Technology – The Next Steps. Atlas Project. European Commission DGXVII.

greater commercial attention to the concept of energy services, selling warmth rather than kWh. Annex 3 discusses the issues in more detail and outlines some options for the way forward.

4.8 And there can be systemic innovation with synergies between technical and market changes. As an example, we identify in Annex 4 the potential linkages between a potentially important new home energy efficiency product (micro-CHP), new metering technology and energy services marketing

5. Energy Efficiency Policies

5.1 This section sets out proposals for energy efficiency policy to 2010. It is based on the analysis undertaken of the scope for improvements and barriers to change. In addition, it takes account of the need for policy on this timescale to encourage innovation in energy efficiency to set the UK on course for a sustainable energy economy in the longer term.

Principles – What are we trying to do?

5.2 The scope for energy efficiency improvement is large. Three broad approaches might increase the rate at which that improvement occurs:

- overcoming the reasons that decision-makers (whether in business or households) do not invest, i.e. reducing the barriers to energy efficiency.
- raising the marginal cost of energy, which will tend to reduce some barriers, make existing energy efficiency options more economic and encourage the development of new ones, and
- expanding the scope for long-term energy efficiency by encouraging innovation in energy efficiency technology and practice.

In essence, policies to address barriers seek to secure implementation of cost effective investment opportunities. Pricing policies seek to make technical possible measures economic. And innovation policies seek to make thermodynamically possible options technically available. The types of policies that can address these three broad goals are set out below.

5.3 But policy effectiveness is not the only concern. Because of the significant market failures identified above, policies to increase energy efficiency will tend to be ‘win-win’ for the UK as a whole. But, like all economic changes, there may be losers in some sectors. ‘Trade-offs’ that may be of particular concern for energy efficiency policies are:

- effects on international competitiveness due to price changes,
- increased regulatory costs on business,
- impacts on income distribution from policy instruments in the household sector, and
- regional and sectoral impacts resulting from declining demand for particular fuels.

5.3 Policies to address energy efficiency also need to take account of ‘the rebound effect’, i.e. where energy efficiency reduces energy costs there is some propensity to take some of the benefits by using more energy services. Our analysis indicates this effect is usually

quite small. However, there are important exceptions, notably in low income households, where energy efficiency gains are taken primarily in warmth rather than cost savings.

5.4 The conclusions from our analysis that underlie the choice of policy instrument are set out in the following sections:

Policies to Reduce Barriers to Energy Efficiency

5.5 Given the importance of bounded rationality and limited motivation, we believe that the best policy options are those that seek to give people or organisations both the incentive and the capacity to implement energy efficiency. This requires Government to do two things:

- identify the organisations best placed to deliver in each energy using sector and provided them with the incentives, and
- where necessary, assist in capacity building.

5.6 Government has, in practice made a start on this agenda:

- For low income households, the Government and devolved administrations have taken direct responsibility through public expenditure funded programmes; and
- For domestic energy users the Energy Efficiency Commitment is a regulatory measure that gives incentives to licensed gas and electricity suppliers.
- In new buildings, Building Regulations give energy efficiency responsibility to the builders;
- For domestic appliances, EU standards and negotiated agreements increasingly give incentives to the manufacturers;
- The Climate Change Negotiated Agreements give a strong fiscal incentive to the industrial sectors involved;
- In the public sector, Government departments have energy efficiency targets;
- For cars, there are EU agreements with vehicle manufacturers;

A large number of other policies and programmes give supporting information and incentives. We will seek to build on this agenda. However, a target setting and regulatory approach needs to be used with care. Whilst it can cut through the raft of market failures that restrict energy efficiency investment, it is important that it does not introduce new rigidities or discourage innovation. To this end, long timescales and tradable mechanisms are preferable. The detailed proposals on policy below take this into account.

5.7 Our analysis indicates that there remain sectors where no-one has a very strong incentive to deliver energy efficiency. In the commercial sector and those industries outside negotiated agreements, there is currently no strong driver on anyone. The Climate Change Levy will provide a price incentive, but where price elasticities are low, the energy saving impact will be limited. For large business energy users, the primary responsibility needs to rest on the users themselves, with incentives provided by

Government. For smaller users, the situation is less clear-cut and we believe that the equipment supply chain, energy suppliers and landlords may be able to play a larger role.

5.8 Product regulation can address some barriers, for example motivation, information and split incentive barriers. It does this by excluding low efficiency products from the market. It is likely to be particularly effective in markets where barriers are strong and where energy costs are small in relation to other costs, e.g. for buildings and consumer products. Regulatory instruments need to be targeted carefully and, like other policy instruments, subject to Regulatory Impact Analysis. Regulatory timescales should be long to minimise business uncertainty. Where products are internationally traded, the EU will be the appropriate level for this type of regulation.

5.9 Negotiated agreements may be used as an alternative in some cases. These have more flexibility than 'command and control' regulation, and therefore may well be suitable for complex situations. They are also more likely to engage businesses in effective early action. However, to maintain public confidence, it is important that negotiated agreements are transparent, not only to Government and business, but also to third parties, through independent monitoring and verification. Negotiated agreements are only likely to be effective where it is clear that alternative policy instruments, e.g. regulation or fiscal, will be used in the event of failure.¹⁸

5.10 Regulation and market mechanisms are not in conflict. New forms of regulation seek to use market mechanisms where these are appropriate. Market creation mechanisms in competitive energy markets will be important for energy efficiency. Key examples are the Emissions Trading Scheme and trading of Energy Efficiency Commitments of energy suppliers. Both allow a given target to be delivered more cost effectively, and thereby potentially allow more ambitious obligations than non-tradable constraints.

5.11 Public expenditure is most appropriate where it is consistent with other goals, in particular to address the barrier of capital access amongst low-income households. It allows vulnerable households to be targeted with minimum deadweight.

5.12 Financial incentives (such as subsidies, tax reductions and enhanced capital allowances) work by attracting consumer attention as well as altering prices. They are particularly effective in addressing the combination of bounded rationality and information asymmetry that otherwise discourages marketing of energy efficient products.

5.13 Financial incentives applied at the point of capital investment or product purchase are more likely than changes in energy prices to influence 'bounded rational' consumers. This type of incentive is most effective when cross-price elasticities are high, notably to differentiate efficient products from less inefficient goods providing the same energy service. This kind of policy instrument design needs to be carefully scrutinised for cost effectiveness and to minimise deadweight loss. This can usually be achieved by limiting

¹⁸ Signed, sealed and delivered? – The role of negotiated agreements in the UK. Green Alliance.

incentives to the most efficient products and by periodic review to promote continuous improvement and innovation.

5.14 Capacity building is necessary where organisations do not have the skills or resources to play the role that will be required of them in expanded energy efficiency investment. This is not generally a problem in large companies. But the energy efficiency sector is dominated by SMEs, which do not generally have the resources to promote training or rapid innovation. For domestic and small business energy users, local authorities and the voluntary sector may also have a key role to play, and they face resource problems. Only Government is in a position to catalyse capacity building in these sectors and to promote the partnerships across the sectors that will be needed. Capacity building will include providing advice, but, in some case, may also require the provision of incentives and resources as well.

5.15 Government also has a role in addressing the barrier of lack of trust in many energy efficiency trades people. Business can play its own part through industry led accreditation schemes. However, experience in the UK and elsewhere indicates that programmes backed by public and voluntary agencies can secure greater uptake. But ensuring that a skilled workforce is in place to deliver a rapidly expanding programme of energy productivity will require Government support for training.

5.16 Government already supports energy education through the work of CREATE. Education can improve the energy consumers' understanding of the principles of energy use and its relationship to environmental problems. In the short term, compulsory education has limited impact - only affecting children's own behaviour and their ability to 'pester' parents. The practical involvement of community groups in energy saving projects needs further encouragement, building on the initiatives of the Energy Efficiency Partnership for Homes. The longer-term role of both school-based education and lifelong learning can be much more significant in affecting culture, knowledge, attitudes and behaviour.

5.16a Government has a major role through the public sector, not only in direct improvements in energy efficiency, but also in setting an example in the wider economy. This will require addressing the barriers that affect public sector energy efficiency, in by setting targets for energy efficiency, then allocating the resources to deliver them. Procurement policy will play a key part in this.

Policies to Increase the Marginal Price of Energy

5.17 In order to optimise economic efficiency, the price of energy should reflect all the costs of its use, including impacts on the environment. Taxes and market-based instruments such as trading schemes can achieve this and therefore address the barrier of pricing external costs. However, the price mechanism alone will not address most of the market failures affecting energy efficiency. Price elasticities of energy use are generally reckoned to be low, partly because of these barriers.

5.18 On the other hand, energy prices affect the culture in which decisions are made. The expectation that energy prices will fall is unhelpful for energy efficiency, as it reinforces tendency to neglect energy costs. The price mechanism therefore has a role in the long-term policy framework. It is the expected price level that is important, as major increases in energy efficiency are likely to be difficult to achieve with falling real prices

5.19 Price changes at socially acceptable levels will not deliver the scale of change that is needed. Some models indicate that using a carbon tax alone as a policy instrument a level of £240 would be required just to deliver the Government target of a 20% reduction in emissions by 2010¹⁹. This would raise gas prices by between 72% (for domestic customers) and 125% (for industry). A combination of price instruments and other approaches to address other market failures is far more likely to be effective and socially acceptable.

5.20 Price incentives may be introduced by energy (or carbon) taxes or through tradable permits schemes in which energy (or carbon) use is capped. Implication for energy efficiency and emissions reduction may therefore be similar. The distributional effects may, however, be different, depending on the specific arrangements for each approach. For example, taxes will by definition raise revenue which can be used by Government for any of a number of purposes. These purposes may include hypothecation to schemes that support the aims of the tax, or recycling to those affected in order to reduce damage to competitiveness and costs to the less well-off. Tradable permits may raise similar revenues for Government if the permits are auctioned. However, these schemes can also be introduced with some element of free allocation, in which case the revenues raised will be less, or at the limit non-existent.

Policies to Encourage Innovation

5.21 As outlined above, market creation, through ‘intelligent regulation’, can address the same barriers as more traditional regulation. In addition it can stimulate innovation by providing niche markets - setting targets for improvement without specifying technical solutions. Trading schemes offer certainty of outcome – consistent with “fixed” environmental constraints – but also allow flexible and novel solutions. Market creation can also deliver early markets for new products and services. It therefore has a major role to play in the innovation chain between demonstration and mass exploitation. Policies to encourage long term innovation in the energy sector in general will be addressed elsewhere in the Energy Review. Issues specific to the demand side are addressed below.

5.22 Government has a major role in supporting and incentivising R&D, both to encourage pre-commercial innovation in general and specifically in environmental technologies. Evidence from the USA indicates that Government funded R&D on energy efficiency can be highly cost effective compared to other energy R&D.²⁰ In the UK, per capita energy efficiency R&D expenditure is very much less and significantly lower than

¹⁹ Department of Trade and Industry. The Energy Report – Shaping Change, 1997.

²⁰ US National Academy of Sciences report. Energy Research at the DOE: Was it Worth It?.

on the supply side. This has been exacerbated by the privatisation of key energy industries that previously undertook most energy efficiency R&D. We accept that this problem needs to be addressed. The Carbon Trust plans to use a significant portion of Climate Change Revenues to increase low carbon R&D (including energy efficiency). And the Government's Chief Scientific Advisor has set up an advisory group on Energy R&D that will, amongst, other activities review whether public energy efficiency R&D expenditure is adequate.

5.23 Voluntary agreements can be used to explore new approaches with organisations or sectors that are already strongly committed to delivering the Government's environmental goals. Policies should therefore seek to involve businesses and to encourage innovative energy efficient goods and services.

5.24 Government can play a key role as a promoter of energy efficiency innovation, through its own procurement policies, incentive schemes to develop niche markets and by building partnerships between market players in the (generally rather weak) energy efficiency sector. Central Government also needs to ensure the effective participation in this type of initiative of those parts of the public sector with a large stock of buildings (notably health, education and defence).

5.25 Policies that seek to transform the market from energy units to energy services can address a wide range of barriers and have a big long term potential, and therefore should be given high priority, even though the short-term problems are significant. New market structures will require changes in philosophy and practice in energy markets – away from energy as a commodity, towards energy as a service. New approaches need to be encouraged (see Annex 3).

Joining-up policy

5.26 Market transformation will tend to require a number of different instruments working together to address the different parts of the market. Fiscal, regulatory, market creation, incentive, information and marketing approaches therefore need to be designed together. This will involve UK Government (DEFRA, DTI, DTLR and HM Treasury), but also EU institutions, the devolved administrations, local Government and, in future, possibly regional Government. There is already close co-operation in some cases and Government recognises the need to continue to look for improvement. Some institutional change may be needed to deliver this, but this should avoid the creation of yet more agencies. Further work on institutional structures will be undertaken in the Review when the shape of future policy recommendations is clearer.

6. Specific Policy Proposals

6.1 Current policy is set out in the UK Climate Change Programme, of which energy efficiency is the major part. This section sets out some options to build on that programme, but also to address the more substantial environmental challenges of the longer term.

Domestic

6.2 The Government's long-term aim for energy efficiency policy for the domestic sector is self-sustaining energy efficiency markets. These will include strong markets for energy services, where the energy service supplier takes responsibility for the optimum mix of energy and energy efficiency. Because barriers to energy efficiency investment are persistent, this will not be achieved rapidly. Government policy for the medium term therefore will need to follow a twin track approach:

- developing the incentive framework for viable energy services, whilst
- delivering programmes and developing policies and mechanisms that increase energy efficiency activity in the current market structure.

This will build on existing capacity and engage new actors; whilst developing a fiscal and regulatory framework and pilot programmes for energy services. This section sets out how that might be achieved.

6.3 The Climate Change Programme target for domestic sector of 5 MtC/year by 2010 will require a substantial increase in energy efficiency activity. If Government's goals are to be reached this will need to continue into the long term. **One way to identify the importance of this would be for the Government to set a target of reducing emissions from the domestic sector, say by 10% per decade.** This would be broadly in line with the Climate Change Programme to 2010 and our provisional analysis of longer term options. **We invite comment on the principal and level of any target, and whether further policy measures would be needed to deliver it.**

6.3a Changes in consumer attitudes will not occur at the rate necessary for this to be delivered without Government intervention. Additional incentives for householder will help, but will not be sufficient. Achieving 2010 targets will therefore need to rely to a large extent on expansion of existing Government and energy supplier programmes. We recognise that this risks reduced incentives for investment by householders. Policy instrument design needs to ensure that the programmes are given incentives to innovate and encourage greater householder involvement in energy efficiency work. It also needs to address any supply side constraints.

6.4 The Climate Change Programme and the UK Fuel Poverty Strategy set out the targets for 2010, but not the level of investment, sector capacity and skills needed to deliver the measures required. Some key players in the energy supply and energy efficiency industries are not yet fully convinced that the scale of programmes needed to deliver the Government's goals will be maintained. **One option to address this, building on the Climate Change Programme and Fuel Poverty Strategy, would be for the Government, working with the devolved administrations, to develop a comprehensive 10-year Home Energy Efficiency Strategy.**

6.5 In this context, our options for policy are in six broad packages, all of which build on existing approaches:

- The continuation and expansion of Government funded schemes and Energy Efficiency Commitments until 2010, along side correspondingly greater activity by local agencies and in training to ensure effective delivery.
- Capacity building in the local authority, voluntary and energy efficiency manufacturing and installation industries,
- An informed public debate on the role of energy/carbon price mechanisms in this sector,
- Building Regulations and product standards to provide a long-term framework for low energy homes.
- Greater attention to action from the ‘home mover’ through a combination of regulation, information and incentives, and
- Reform of energy regulation and fiscal policy to provide a clear incentive structure for energy services markets.

Government and Energy Supplier Programmes

6.6 The Home Energy Efficiency Scheme (and related schemes of the devolved administrations) has a key role to play in improving energy efficiency and reducing fuel poverty. Government has a goal of eliminating fuel poverty in vulnerable households by 2010 and all households by 2015. This is a key objective of social policy. But it will also be an important contributor to energy efficiency and climate change objectives. **We invite comment on the level that might be appropriate for HEES in the period up to 2010, in the context of climate change and fuel poverty targets.**

6.7 A 10-year Home Energy Efficiency Strategy would provide reassurance of the Government’s intention to continue substantial programmes to 2010. The programmes do not currently provide all the support needed to remove from fuel poverty the lowest income households in some homes with solid walls, which have the worst insulation. The Government already intends to give greater attention in its fuel poverty programmes to these ‘hard to heat’ homes. The development of micro-CHP may provide important opportunities here (see Annex 4). The Government intends to address these issues in the forthcoming Fuel Poverty Strategy. **We invite comment on the approach to micro-CHP that might be included in any 10-Year Home Energy Efficiency Strategy and other measures to address hard to heat homes.**

6.8 The Energy Efficiency Commitments (EEC) are expected to deliver the largest carbon savings in the domestic sector. They will have to continue and increase in scale to deliver the 2.6-3.7 MtC of carbon savings set out in the Climate Change Programme. Working alongside Government funded fuel poverty programmes, EEC can play a broader role across all social groups. **We invite comments on the future of EEC, including the length of time for which this mechanism should be used, and the scale of energy efficiency activity it should deliver.**

6.9 EEC currently operate as obligations on energy suppliers to deliver energy efficiency. There is no expenditure requirement. In this way, they provide an opportunity for energy suppliers to improve profitability by delivering the obligations more efficiently than their

competitors and act as a driver for innovation. This provides an incentive to delivery through energy services (i.e. with a customer contribution), which is important in maintaining scope for market innovation. **We invite comment on whether and how EEC might be developed to provide further incentives for marketing of energy services.**

6.10 However, there is no guarantee that EEC, as currently structured, will entirely offset the increase in demand for energy. They provide an incentive to suppliers to support energy efficiency projects rather than to reduce energy demand. An alternative approach would be to reform the EEC obligations into a tradable cap on energy (or carbon) supplied per customer. In principle, this could be linked into the Emissions Trading Scheme, although the implications of these would need detailed investigation. This could address the Government's environmental goals directly and provide a very clear signal that increased energy use in the home is unsustainable in the long term. Making the caps tradable would minimise the costs of delivery for any given demand reduction. However, there might still be concerns about the effects and practicability of supply cap obligations in competitive markets, including the treatment of energy savings funded by a supplier when a customer switches to a competing supplier. However, if the benefits of energy efficiency investments remained credited to the supplier that induced them, this might provide an incentive towards long-term energy service relationships. Nevertheless, tradable caps on energy (or carbon) supplied for household use would be a major change. It would be important to assess the potential impact on lower income households, especially those in fuel poverty. For the period up to 2005, the Government proposes to retain the existing approach to EEC, and we support this. Some of the issues surrounding the use of a tradable supply cap in the longer term are set out in Annex 5. **We would be interested to receive comments on the tradable supply cap mechanism set out in Annex 5 or alternative approaches in the domestic sector.**

Capacity Building

6.11 Ambitious home energy efficiency and fuel poverty goals need to be well co-ordinated if they are to be properly targeted and delivered efficiently. Currently activities on the ground are divided between many organisations, including energy suppliers, the managing agents of Government programmes, local government and the voluntary sector. We recognise that there is concern this is not working effectively and that Government has a role in capacity building and co-ordination. One example of current activity is the Warm Zones initiative, involving a number of key partners in the delivery of energy efficiency programmes in local areas. This may provide useful information on the way forward. The Government intends to review results in the current pilot Warm Zone areas for lessons on the best ways to deliver home energy efficiency and fuel poverty programmes.

6.12 Local Government is often well placed to act as a co-ordinator and facilitator of local action, working in partnership with other agencies. If this is to be done effectively, energy efficiency needs to be brought into the mainstream of local authority work. A review of local authority energy efficiency duties is being undertaken. The

Government's objective in the review is to identify the best role for local authorities. Our analysis indicated that it may be important to ensure that local authorities have the powers, duties and funding necessary to play a much bigger role in co-ordinating and targeting local energy efficiency work. The review will also address the relationship between local authorities and specialist energy efficiency agencies, for example Energy Efficiency Advice Centres (EEACs). The voluntary sector could also play an enhanced role, especially in more innovative approaches, but it is severely under-funded. **We would be interested to receive comments on the future role of local authorities and the voluntary sector, including on the additional energy efficiency resources that might be required.**

6.13 Rapidly expanding energy efficiency markets are already imposing strains on the capacity of gas appliance installers. This is exacerbated by an ageing profile of the workforce, stemming from declines in training since privatisation. A number of initiatives are underway with Government and private sector funding. In addition, new gas installer courses are beginning in Colleges of Further Education. The Government intends to review these initiatives and to continue to work with interested parties to ensure that training needs are identified and met. **We would welcome views on the best way forward to develop energy efficiency training.**

Price Based Instruments

To be developed

Building and Product Standards and Policies

6.19 Building Regulations are critical for long-term energy efficiency. Historically they have been a very cost effective tool, and the plans for further improvements in energy efficiency requirements are a significant advance, especially as they will include provisions concerning heating systems and windows in existing buildings.²¹ Given the large proportion of energy used in buildings, our goal of a low carbon economy will not be delivered without low energy buildings becoming the norm. This will require major changes to long-term building practice, including enforcement, to bring the UK up to the standards of other northern European countries.

6.20 The Government recognises that there are serious concerns about the regulatory impact on the building sector of major changes if this is brought in too quickly. Better regulation requires long term planning to give greater certainty to business. **One option would be for the Government to set out an approach that would develop Building Regulations as a market transformation tool over a longer period – we invite views on this. For example,** as a first step this might involve setting out a framework for future changes to the energy component of Building Regulations. Subject to Regulatory Impact Analysis, this could seek to move progressively to new buildings with minimal space heating energy requirements, e.g. over 10 years, and a requirement for use of renewable energy, e.g. over 20 years. It might also be important to address existing

²¹ Building Regulations. Part L Approved Document. DETR, May 2001

buildings. **One option would be a requirement that existing homes should be brought up to a level that is achievable with cost effective measures (e.g. a SAP rating of 60) over a long period, e.g. by 2015. We recognise that this will involve detailed consultation with the materials supply, construction industry and other stakeholders, but invite comments at this stage on the general approach.**

6.21 For energy using appliances, it is important that energy efficiency is part of integrated product policy (IPP). The EU is the appropriate level of government to set standards on traded goods, notably appliances. Energy efficiency labels are currently required on all the major energy using appliances, and minimum standards are in place for boilers and refrigeration appliances. There are synergies between standards, voluntary agreements and product labelling. Labelling requires the same technical assessment and verification systems, and it can provide a stimulus to integrate energy efficiency into corporate planning. The Framework Directive promised in the recent EC Energy Efficiency Action Plan could provide the appropriate context for future action in this area. **We invite comment on the importance of the UK taking the lead in pressing for a more comprehensive and programme of cost effective EU energy efficiency standards and negotiated agreements for lights and appliances, and on the possible content of such a programme.** Developing such an approach would require close collaboration with European partners and the supply chain. It should also pay particular attention to new products in which there may be significant market growth, notably digital TV equipment and air-conditioning, and where early intervention would be particularly effective. All initiatives in this area need to be underpinned by the information of the Market Transformation Programme.

6.22 It is also important to strengthen the capacity of UK industry to respond to increasing energy efficiency expectations. **We invite views on how the Government should encourage appliance manufacturers and retailers to promote super-efficient appliances. Options might include working with suppliers as part of long term EEC plans, broader co-operation through the Energy Efficiency Partnership for Homes, direct subsidies and procurement programmes to develop niche markets for innovative, high efficiency products. We invite comment on the best approaches.**

Home Movers

6.23 In the owner occupied sector, the point of moving house provides an opportunity for change, as changes to the property and new financing are more likely. More than 3 million households move home every year. Moving home has high costs that can discourage energy efficiency investment. However, it is also a time when building work and other improvements are often undertaken, and therefore potentially provides an opportunity for energy efficiency investment that might be considered more disruptive at other times. Incentives may therefore be particularly effective at this point.

6.24 New homes are now required to display their SAP (energy cost) rating. **One option to take forward this approach would be for the Government to introduce new housing legislation along the lines of the Homes Bill 2001 to require a ‘Sellers Pack’**

with a house condition survey that includes provision for an energy audit. This could identify both a list of the cost effective energy efficiency opportunities and/or a ‘one stop shop’ for advice in taking forward the recommendations. **We invite comments on the best approach to providing a co-ordinated package of measures around home movers and how such a ‘one stop shop’ service might be delivered.**

6.25 Differential stamp duty may potentially be an effective measure to incentivise energy efficiency. There would seem to be two broad approaches:

- **making stamp duty dependent on the energy or carbon rating of a home, or**
- **rebating stamp duty if identified energy efficiency measures are undertaken within a given period after purchase.**

We would be interested in comments on the use of stamp duty as an incentive mechanism, which option might be preferable. However, there might be alternative approaches to providing incentives and we would welcome comments on these.

6.26 We believe it will also be important to encourage the private sector to support ‘home mover’ energy efficiency. We also believe it will be necessary for the rules and administration of EEC to allow energy suppliers to deliver their targets from ‘home mover’ schemes. **One further option would be for the Government to seek a negotiated agreement with the housing finance sector that such opportunities will be funded as part of mortgage offers, reducing the cost of finance. We invite comments on these ideas.**

Energy Services and Energy Regulation

6.27 In the longer term, the Government aims to encourage energy services (as opposed to commodity sales) the dominant form of energy retailing in this sector. We propose to look further at the longer term issues this implies elsewhere in the Energy Review. The most attractive commercial packaging for energy services is not something Government can or should try to design. Instead we believe that the policy framework should set the right incentives for commercial energy services. New products, such as micro-CHP systems, may provide opportunities for establishing energy service markets (see Annex 4). **One option would be for the Government to encourage the Energy Saving Trust to continue and/or the new Carbon Trust to introduce appropriate market creation schemes. We invite comments on this or alternative approaches.**

6.28 In the short term, it is critical to change energy regulation to remove regulatory barriers to energy efficiency and energy services. **One option would be that the work to implement the conclusions of the Embedded Generation Working Group should be developed to ensure that energy efficiency projects are properly rewarded for benefits to electricity distribution networks. Another would be for the ‘Reconciliation by Difference’ system in gas supply to be revised to remove disincentives to gas supplier investment in energy services.**

6.29 The regulatory culture established at privatisation treats long-term customer/supplier relationships as inherently anti-competitive. We recognise that this is unhelpful for

energy services and that change is needed. DEFRA is already consulting on the option of providing additional support for energy services in the framework of the EEC. The proposed guidance on energy services²² to Ofgem is a further step in the right direction. **We seek comments on whether this should be extended to be more explicit about the need to reconsider issues such as separate billing and the restriction of customer choice on long-term contracts (the “28-day rule”).**

Business Sector

6.30 Larger business should have the capacity to respond to economic signals. Any strategy for radically increased energy efficiency will need to consider the role of price signals. It could build on the existing framework of the Climate Change Levy (CCL) Package – the CCL itself, the exemptions, revenue recycling, the negotiated agreements and the Emissions Trading Scheme (ETS). Further work is needed in this area, but some possible options for developing Negotiated Agreements and the ETS are set out below. Additional measures will also be brought forward to ensure the existing target for CHP is delivered. But this is not the whole story. Other themes are important. In the commercial sector and most SMEs, the price signal is weak, so other instruments are needed. We will investigate incentivising a bigger role for the building sector, large landlords and energy suppliers. And in the public sector, we recognise that Government has a key responsibility and leadership role.

6.37 The difficulty in delivering the energy efficiency measures implied by the negotiated agreements is hotly debated. A low price for carbon in the ETS might be evidence that the targets need to tightened. **The review of the negotiated agreements in 2004 will consider this and other emerging evidence. We invite comment on the objectives that should inform this review.**

6.38 Integration of the negotiated agreements and emissions trading has proved problematic. In the longer term, it could be that trading makes very detailed negotiated agreements unnecessary. **One option would be for a simpler system of Negotiated Agreements based on a declining emissions cap. We invite comments on these issues.**

6.39 We believe that the importance of greenhouse gas and energy reporting needs to be given statutory force in large companies. **One way to promote this would be for the Government to require an environmental report by major companies as part of company annual reports. We invite comments on the desirability of this.** We welcome the work of Ofgem, DEFRA, the Environment Agency and the Electricity Association on Key Performance Indicators for environmental performance. **We invite views on how these might be used as a basis for reporting for the gas and electricity sectors.**

²² Draft Social and Environmental Guidance to the Gas and Electricity Markets Authority. A Consultation Document of the Department of Trade and Industry, May 2001.

Taking Forward Industrial CHP

6.40 Combined Heat and Power (CHP) is a particular form of energy efficiency as it operates higher up the energy supply chain, and therefore has some of the characteristics of both energy supply and energy efficiency. The Government has set a target of 10,000 MW of CHP capacity by 2010 and this is an important part of the Climate Change Programme. It is therefore important that the CHP target is met. The Government's draft CHP strategy, when published, will set out the approach to delivering this target.

6.41 CHP currently faces very difficult market conditions because of the problems faced by small generators under NETA, the removal of the stricter consents policy and the falling electricity/gas price differential. Enhanced capital allowances will provide some assistance. However, further expansion of CHP forms an important part of energy efficiency improvements required in industry. This expansion seems unlikely to occur at the rate required without further policy support.

6.42 Exemption from the CCL currently applies only to the electricity used on site from CHP installations. We have found no good economic or environmental justification for this. It seems to limit the benefits and risks sub-optimal design of future plant. **One option would be that the CCL exemption should be extended to all electricity generated from good quality CHP installations. We invite comments on this option.**

6.43 However, it seems very unlikely that changes to fiscal policy alone can overcome the very serious reductions in CHP output and disincentives to future CHP capacity that have occurred in the early months of NETA. We believe that it is essential that both wholesale electricity markets and the operation of the regulated distribution networks should be supportive of the Government's policies for sustainable power generation. Our preliminary analysis indicates that urgent change is needed. However, these are complex issues. The Government is already consulting on the impact of NETA on smaller generators. In the light of this, we intend to bring forward recommendations concerning reform of NETA and embedded generation regulation elsewhere in the Energy Review.

Energy Efficiency in Commercial Buildings and SMEs

6.43 SMEs face more barriers in implementing energy efficiency than other businesses, in particular in skills, access to capital and control of the buildings they occupy. If Government messages are to be communicated effectively this may best as part of wider activities. **We will propose in the forthcoming PIU Report on resource productivity²³ that Government should develop a resource productivity strategy for small businesses, including energy efficiency, in conjunction with the small business community.** This should address:

- Information and advice services, provided wherever possible through a "one-stop-shop" approach.

²³ Sustainable Prosperity: Progressing the Economy and Preserving the Environment

- Support for linking advice to installations and other activities to improve resource productivity, i.e. developing the concept of the “service provider” or “enabler”.
- A major role for regional bodies (e.g. Regional Development Agencies and Regional Assemblies) and local organisations, including the existing Business Link networks.

One option would be a comprehensive service of accredited energy audits and personalised advice for SMEs with funding from the CCL. We invite comments on whether and how the Government (perhaps through the Carbon Trust and the Energy Saving Trust) might take this forward. In this context, it would be crucial to ensure this is not a charter for “consultants’ reports left on the shelf”. **One option to avoid this might be for any scheme of this type to link to support schemes – e.g. grants or zero interest loans - for implementation of recommendations.**

6.44 However, we believe it would be unwise to place SMEs under the same sort of obligations for involvement in the CCAs or ETS as larger companies. Intermediaries with a stronger capacity for project management and investment need to be involved in this sector. **Alternative options might include using obligations and incentives on intermediaries - large commercial landlords, builders, the product supply chain and energy service providers. We invite comments on these broad options.**

6.45 Measures to address the barrier of split incentives are especially important in the commercial offices sector. We will seek a far greater level of energy efficiency activity by landlords and property managers. This could include energy audits at each new letting or rent review with a requirement for action if a good practice threshold is not achieved. We believe the Government should support the proposed EU Directive on the energy performance of buildings, as this provides the basis for the necessary audit and certification.²⁴ **One option for securing the investment action needed would be for Government to seek a negotiated agreement with representative bodies in the sector on this. We invite comments on this approach.**

6.46 **An alternative option would be for future revisions of Building Regulations in this sector to develop a long-term plan for a phased transition to mandatory low energy buildings.** In the service sector this might include measures to prevent where unnecessary the adoption, as standard, of air conditioning in new office buildings and earlier requirements for the use of renewable energy. It might also require active promotion of micro-CHP where the commercial and SME sectors may provide a crucial early market (see Annex 4). This approach would require the active participation all key stakeholders in the building ‘supply chain’. **We invite comments on the use of Building Regulations in this sector.**

6.46a Products such as appliances, air conditioning and motors are amenable to the same approach to labelling, standards and voluntary agreements outlined in paragraph 6.21 above. **We invite comments on whether non-domestic products should be addressed in the same way.**

²⁴ COM (2001) 226 final

6.47 Energy services offer a way forward in the commercial sector, possibly more quickly than in the domestic sector as transaction costs are less of a problem. But there are no existing drivers in energy regulation. However, the legislative framework allows for EEC outside the domestic sector. **One option would be to extend EEC to the commercial sector and other non-energy intensive businesses. We invite comment on this approach and the extent to which energy services might be a significant delivery mechanism within it.**

Providing Government Leadership

6.48 Government needs to lead by example in the service sector as Government buildings are major energy users. We believe that targets for emissions reduction set out in the CCP are important goals. **One option to emphasise this would be to update targets regularly and for them to form part of future departmental Public Service Agreements.**

6.49 The use of procurement to improve resource productivity more generally is considered in the forthcoming PIU report ‘Sustainable Prosperity: Progressing the Economy and Preserving the Environment. Government can also play an important role in establishing energy services by purchasing its own energy in this way. **We invite comments on whether, and if so how, Government should develop model energy services contracts for use in tendering throughout the public sector.**

6.50 Procurement procedures should also support high standards of energy efficiency for office equipment bought outside energy service contracts. Life cycle costs not minimum capital costs are already the basis of public procurement guidance²⁵. However, even these do not reflect the environmental costs of energy use. Nor do they take into account the potential for the public sector, as a significant purchaser, to contribute to market transformation through increasing the market for, and thereby reducing the costs of, more efficient technologies. Where products have energy labels, these factors could, in practice, be taken into account within the guidance rules by specifying that the highest rated equipment is routinely procured. **We invite comment on whether the Green Ministers should consider adopting this approach.**

Transport

6.51 Policies to address energy efficiency in transport will be addressed elsewhere in the Energy Review.

²⁵ “Environmental Issues in Purchasing”, guidance note from HM Treasury and DETR.

Annex 1

Energy Efficiency Glossary

Energy productivity is the ratio of economic value (produced or consumed) to energy use. It may be defined at the household, firm or national level. For the UK as a whole, it is the ratio of Gross Domestic product (GDP) to total primary energy use. This captures both technical improvements (energy efficiency, see below) and shifts in economic structure (e.g. the ongoing shift from energy intensive manufacturing to less intensive service activities)

Energy efficiency is a similar ratio of economic value to energy use. It is usually used at the micro-level, so that energy efficiency improvements are technical.

The *thermodynamic potential* is the maximum possible conceivable improvement in energy efficiency, i.e. the limit set by the underlying science of energy and its conversion, thermodynamics. Most uses of energy achieve only a few percent of this theoretical optimum.

The *technical potential* consists of all commercially available energy efficiency technologies.

The *economic potential* is a sub-set of the technical potential that passes a cost-effectiveness criterion, often, by convention, a simple payback time 4 to 5 years.

The *economic potential to 2010* is the part of the economic potential that can be realised, taking account of the capacity and capital constraints.

Annex 2

Energy Efficiency Decision-Making

Opportunities for cost-effective improvements in energy efficiency have existed for many years. Many have not been adopted by businesses and households. In order to increase adoption rates, it is important to understand how businesses and households take decisions regarding energy efficiency and to devise policies to overcome obstacles that inhibit adoption.

Many economists and technologists assume that 'rational' agents adopt cost-effective improvements in efficiency. It is then presumed that, if this does not occur, then there are 'barriers' that prevent it. The sorts of barriers to energy efficiency that have been identified are described below:

Barriers to Energy Efficiency

Our analysis indicates that the most important barrier is the limited attention given to energy efficiency, arising largely from the low proportion of total costs spent on energy in most household and businesses. This generates a 'psychological hurdle' for energy efficiency that is manifested in both:

- lack of motivation to consider energy efficiency projects, so that discretionary investments are not made, and
- 'bounded rationality' in other investments, i.e. limited time and resources leading to the systematic neglect of benefits of energy efficiency.

Other major barriers are:

- Imperfect information. In neo-classical economic theory, without perfect information people, cannot make 'rational' decisions. Where bounded rationality is operating, imperfect information is significant if it forms part of the rule of thumb or procedure used to make a decision. In general, information has 'public good' characteristics which means it is likely to be under-supplied. The vast majority of energy consumers and a large number of relevant tradespeople have imperfect information about the range and performance of energy efficient products.
- Access to capital. The lack of access to capital is clearly a barrier in the case of fuel-poor households and public-sector managers subject to direct capital constraints. Within commercial companies capital is often rationed or less available for small investments. Organisations will impose much higher rates of return on small investments. This is partly to offset the transaction costs, which are similar for all sizes of investment. It is also due to distrust of the agents proposing the investments. This is also known as the *principal-agent* problem and can be regarded as a case of asymmetric information. Businesses are also reluctant to increase borrowing since this increases the risks associated with higher gearing. In the domestic sector it is quite hard to obtain loans of a few

hundred pounds without paying very high rates of interest – which undermines any savings achieved.

- **Credibility and Trust.** When a householder or businessperson receives new information its impact will largely be determined by the credibility and trust placed on the source of information. In general households and business people will distrust people who have an obvious a vested interest in the information (e.g. savings estimates from double-glazing sales people). They may also distrust a source giving advice that goes against the perceived interests of the source, e.g. fuel companies giving advice on how to save fuel.
- **Transaction Costs.** The costs of finding information, negotiating agreements and contracts and organising purchasing agreements are all examples of transaction costs usually excluded from cost-effectiveness calculations. However where these have been measured they have been found to be small, less than 10% of costs, and apply equally to purchases of high and low energy efficiency.
- **Split incentives.** This occurs whenever the costs and benefits of an investment accrue to different agents. The classic case is that of a landlord and a tenant, neither of who has an incentive to invest in improving the property. This is important in both domestic and service sectors. Another example in the domestic sector is house-builders and purchasers. Here the builder would bear the cost of the improvement and the purchaser the benefit. Within businesses split incentives occur between departments, for example where a purchasing department is not accountable for running costs.
- **Adverse selection.** This refers to a case of asymmetric information between seller and purchaser that results in good products being driven out of the market by poorer products. Because builders/developers, surveyors and estate agents do not factor running costs into prices, builders are encouraged to work to the lowest allowed standard, thereby undercutting homes and offices with better energy efficiency. A similar situation applies to most appliances, both domestic and commercial, because the purchaser is often not provided with (nor seeking) information on running costs.
- **Fiscal barriers.** VAT is charged at a higher rate on most energy efficiency investments than on energy for domestic use. Energy efficiency investment in the home cannot be set against tax in the same way as supply side expenditure.
- **Regulatory barriers.** Gas and electricity supply licences do not allow suppliers and customers to have enforceable long-term contracts for energy services.
- **The uncertainty of value for money work being carried out in the home, both in terms of the market rate and how to assess the quality of work undertaken.**
- **The lack of any effective international trade in some products, partly due to use in the UK of outdated imperial measurements in construction and equipment.**
- **Skills shortages, partly resulting from the transition from monopoly to liberalised markets.**

The Market Failure Debate

In a paradigm of economic rational decision-making, it is ‘market failures’ that cause inefficiency. The extent to which the barriers listed are market failures has been debated

extensively. Some – like fiscal and regulatory barriers – are clearly market failures and this is not disputed.

In other cases the situation is more complex. For example, it has been argued that the very high potential costs to individual consumers of acquiring, processing and acting on information about energy efficiency investments is a real cost that needs to be factored into the analysis. This is correct if it is assumed that current market structures are fixed. But they are not. A number of policy and commercial interventions can change market structures and reduce these transaction costs. Government fuel poverty programmes, product standards and energy service markets are examples. These are policies recognise the existence of cost effective energy efficiency and then change market structures to assist its implementation. The effect is to improve economic efficiency. As economic efficiency is higher with the policy than without, it is arguable to infer that there is a market failure that has been addressed.

Similar arguments apply to the issue of whether ‘bounded rationality’ is a market failure. Arguably, it is not. People are faced with a wide array of data on which to make decisions. It can be claimed that, if they pay little or no attention to some of that data, that is their decision and, because it is freely made, by definition, it maximises their economic welfare. In this analysis, all decisions made in a ‘free market’ are automatically optimal. It risks losing any objective sense of economic efficiency. Efficiency is normally defined with respect to costs and benefits of an action. One result of bounded rationality is that decisions result in lower economic benefits than is possible. In this sense, bounded rationality itself is a market failure.

It can be seen that the discussion about market failure becomes rather theoretical and ultimately rather unproductive. Whether some of the barriers are defined as market failures or not is largely irrelevant to the design of good public policy. If they reduce economic efficiency, there is a case for intervention to improve it.

Furthermore, energy efficiency can contribute to other policy goals, notably energy security, environmental improvement and social inclusion, that are not always captured in assessments of economic efficiency

Other Perspectives on the Barriers

The key barriers are not open to easy ‘correction’. Lack of motivation and bounded rationality are pervasive in our society. Policies will not be designed that remove them. Designing practical policy requires attention to what will work.

In analysing consumer behaviour, it is important to recognise that ‘irrationality’ in an economic model is not the same as unreasonable behaviour. In order to understand how businesses and households take energy efficiency decisions, it is essential to take into account their perceptions and constraints, as well as their organisational and cultural contexts.

In a small minority of businesses in energy intensive industries, energy efficiency is critical to business goals. Elsewhere it is not. For the average, manufacturing business, energy forms only 1.6% of business costs. In the service sector the figure is lower still. In this context, management priorities are elsewhere and investments specifically to reduce energy costs are rarely considered. In other decisions that involve energy efficiency, other issues – labour costs, product quality etc. – will invariably be given greater attention. Energy cost saving is not a primary motivator.

Decision-making with limited management resources requires the use of imperfect information and less than fully ‘rational’ procedures. This is embodied in the theory of ‘satisficing’ or ‘bounded rationality’²⁶. In addition, groups and individuals within organisations have many different goals that influence decisions. Constraints on staff time, access to capital and bounded rationality have been found to be the major factors restricting adoption of energy efficiency in both public and private sectors²⁷.

Household decision-making is also subject to bounded rationality. But there are additional factors. Households do not perceive their goals in purely economic terms. Additional issues involving lifestyle, status and fashion can be at least as important. And in the absence of formal decision-making criteria, economic decisions focus on proxies such as brand trust and bargain seeking, not cost benefit analysis. Because energy efficiency is ‘invisible’ it is not perceived as providing a direct benefit. For the average household, energy bills (excluding transport) form less than 3% of expenditure. Interest and motivation in energy saving therefore tends to be weak. Energy efficiency is far more likely to be conceptualised as ‘expenditure’ than as ‘investment’. And the tax system discriminates against energy investments in the home. Where there is an environmental motivation, knowledge about the links between energy use and environmental impacts limits effective action.

Even if the concepts are understood, taking action is problematic due to:

- difficulties in finding useful information on the performance of different measures,
- the need to contact different companies to acquire a full package of measures, and
- lack of trust in many the agencies involved, including the fuel companies, retail sales staff and installers.

The activities of Government in addressing these barriers to improve energy efficiency have traditionally been limited. For most of the 20th century, the emphasis on energy policy was on expanding the major networks and security of supply. This involved close co-operation between policy-makers and the energy supply industry. The expansion of electricity networks throughout the developed world relied heavily on this nexus²⁸. The demand side had a lower policy profile, with far less interaction between policy-makers and energy users. Improving economic efficiency became a more important theme of

²⁶ Simon, H.A. *The new Science of Management Decision*, Harper & Row 1960.

²⁷ Sorrell, S. et al. *Barriers to energy efficiency in public and private organisations*. Science Policy Research Unit, Sussex University.
<http://www.susx.ac.uk/spru/environmental/research/barriers.html>).

²⁸ see Hughes, T.P. *Networks of Power*. John Hopkins University Press, 1983.

policy with market liberalisation in the 1990s. But even then, the emphasis was on the supply side, with a narrow focus on lower prices, rather than lower costs. Regulators have given a low priority to addressing the market failures that result in sub-optimal end use efficiency.

Further analysis is provided in PIU working papers.²⁹

We conclude that energy efficiency policy needs higher priority in energy policy as a whole. Specific policy options need to consider the way decisions are actually made. Simplistic assumptions assuming economic ‘rationality’ are unhelpful. And the extent to which the barriers to energy efficiency are market failures is primarily of academic interest. Policies can reduce the barriers to investment in cost effective energy efficiency, but to do this they need to ‘work with the grain’ of real decision making, accepting the practical constraints on time, attention, skills and interests in real businesses and households. Successful policies therefore need to bear in mind the ‘barriers’ identified.

²⁹ Chapman, J. and Eyre, N. Energy Productivity to 2010 – Potential and Key Issues. Summary on <http://www.cabinet-office.gov.uk/innovation/2001/energy/energyscope.shtml>

Annex 3

Energy Services

What are Energy Services?

Energy services are defined as the services, required by society, that are derived from the use of energy. Although the concept applies across all uses of energy, the usual examples are those familiar to households:

- comfort – from the use of energy for space heating,
- illumination – from the use of energy for lighting, and
- mobility – from the use of energy for transportation.

Although energy services are what people want, they are more difficult to measure than kilowatt-hours.

Why do Energy Services Matter for Energy Efficiency?

What is generally bought and sold in energy markets is an energy commodity – kWhs of coal, oil, gas and electricity – which is a demand derived from the demand for energy services. There is good reason to believe that this is not helpful to energy efficiency. Energy suppliers generally have better information, higher skills, cheaper capital and more ‘rational’ decision making processes than end users. They are therefore well placed to assist users with energy efficiency investment. However, with most tariff structures, the energy supplier has an incentive to sell more units, and therefore a disincentive to help the end user improve their operational efficiency. Charging for kWhs places the economic incentive to improve end use efficiency solely on the end user. Energy service markets might overcome this.

So there is good reason to believe that energy service markets would increase energy efficiency investment to a level closer to the economic optimum. The relevant public policy objective is to increase cost effective energy efficiency investment. However, for market actors, energy service marketing will only be the goal if this wins new customers or increases profitability. This is the goal for energy services policy.

What are the Prospects for Energy Services Marketing?

It is not inevitable that energy markets should be of the ‘commodity’ rather than the ‘energy service’ variety. When Edison began electric utility operation in New York he charged by the bulb, i.e. essentially for illumination rather than electricity. With the development of larger scale transmission systems, non-lighting demands and electricity metering, it became easier to charge for the commodity and this became the standard approach in network energy systems (gas and electricity) throughout the world.

In many countries, some elements on an energy services offer have been developed. In the industrial sector, some specialist energy service companies provide professional operation of steam production and other ‘energy services’. Some traditional monopoly

utility companies, particularly in the USA, developed extensive energy efficiency programmes, largely under the influence of regulatory regimes that controlled prices in such a way as to make this the most cost effective business model. A similar model exists in the liberalised, but still regulated, markets in Great Britain with the Energy Efficiency Commitments (EEC). **But nowhere has a full domestic energy service company model been developed, in the sense of a major business offering to sell households the energy services they want, rather than a commodity.**

The institutional structure of energy markets and the players in them tend to plan, produce, transport, market, meter and regulate in energy units not energy services. The changes that are required in the institutions of energy systems if energy services are to become the mainstream should therefore not be underestimated.

With the liberalisation of energy markets some commentators suggested that energy service markets would arise spontaneously. This was founded on the assumption that it was price regulation in gas and electricity markets that introduced a 'regulatory barrier' to the development of energy services. Whilst it was certainly true that monopoly regulation introduced disincentives, this was far from the whole truth. There is no energy services marketing in the oil and coal sectors either. The other barriers to energy efficiency create difficulties for marketing energy efficiency, whether through energy services or otherwise, especially to domestic consumers.

However, market liberalisation certainly offers more scope than traditional utility markets. Full electricity and gas market liberalisation in Great Britain dates from 1998. In the early years, the emphasis has been on cost reduction, price competition, customer acquisition and rationalisation. None of these is helpful to the development of more complex service offers. However, as costs converge, it seems likely that suppliers will want to offer higher added value services. So far this has concentrated on low cost options – notably dual fuel deals – rather than high capital cost energy efficiency measures.

Where are Energy Services in the UK?

There are already active energy services markets within industry in the UK. But in SMEs and small businesses, no self-sustaining market has been established. Some limited energy service offers have been developed, largely with seed corn funding from the Energy Saving Trust. There are two broad approaches:

- energy supplier offers, and
- joint energy supplier / housing provider activities.

Most of the major energy suppliers to the domestic sector have tried energy services. None has yet been sufficiently confident to make the major marketing commitment that would be necessary to raise the profile enough to take energy services out of being only a niche activity.

Some of the most successful, but small, attempts to develop energy service markets have been joint ventures between energy suppliers and social housing providers – local authorities and housing associations. The latter can potentially offer cheap customer acquisitions to suppliers and through these gain bulk purchase benefits on energy prices that can be converted into energy efficiency investment. This type of innovative partnership between energy suppliers (with energy market and technical strengths) and housing suppliers (with housing investment and customer contact strengths) may offer an alternative route forward for energy services.

The Role of EEC

In the short term EEC is likely to be critical to any energy service marketing as any energy efficiency delivered can be counted against the supplier's obligation. Indeed, without EEC, it is very doubtful if there would be energy services activity at present in the domestic sector.

EEC have been restructured since April 2000 to provide incentives for suppliers to deliver the obligations through energy services. As suppliers are no longer price controlled, there is no obligation to spend a particular amount of money to deliver EEC targets. In a competitive supply market the commercial pressure will be to deliver EEC obligations at lowest cost. Any supplier that can deliver at lower costs than its competitors will profit.

EEC therefore is supportive of energy services. In a typical energy services offer, the supplier will fund energy efficiency capital investment then recover the funds over an extended period of time. Under EEC rules, the whole energy saving counts against the obligations. So, through energy services, the supplier can deliver the obligation cheaply.

This has generated some new products from a number of suppliers. But experience in the market is still not very encouraging. Consumers remain largely unaware of the option, it is not heavily promoted, it is a new concept for most households and counterintuitive that an energy supplier is offering energy efficiency. No supplier reports that a viable market exists outside regulatory requirements. Even within EEC, energy services may not be the best approach, as there are additional costs compared to alternative approaches, such as capital subsidy at the point of purchase.

There is discussion of what more can be done to encourage energy services with EEC. Options include a banded obligation, in which a fixed part of the obligation has to be delivered through energy services. The Government's preferred option on which it currently consulting is to give a higher weighting in the assessment of EEC to measures delivered using energy services, reflecting the increased likelihood that they will be sustainable.

Regulatory Issues

There is a long-standing debate about regulatory barriers to energy services. There are several issues, of which the most important is the 28-day rule - a requirement that prevents energy supply contracts tying domestic customers for more than 28 days. Related energy efficiency contracts can be longer, but suppliers may be reluctant to make energy efficiency investments if the customer can transfer, leaving the supplier as a debt collector only. One objection to the rule is that it is a denial of customer choice – preventing customers having binding longer term contracts even if they want them. The alternative view, taken by both the regulator and consumers representatives has been that the rule is important for customer protection.

Much of the debate stems from basic energy policy objectives. If the public policy objective is for energy markets to provide energy units at the lowest price, then energy services are not the way forward. If, on the other hand, the objective is the to deliver energy services at the lowest sustainable cost, then long term service contracts, rather than kWh spot prices may be more advantageous and regulatory constraints on energy services marketing unhelpful.

We conclude that energy service markets for smaller consumers may prove difficult to develop. It would be unwise for Government policy to deliver energy efficiency improvements by 2010 to rely on energy services markets being strong by then. On the other hand, self-sustaining energy service markets offer very large long term potential. It is therefore crucial that Government encourages their development, without seeking to determine a ‘correct approach’ that prejudges commercial innovation. We believe that the best framework for Government action is to:

- review and correct regulatory disincentives to energy services marketing,
- provide incentives both through the structure of EEC, and
- encourage, and where appropriate, incentivise more innovative approaches, including the incorporation of energy services in to wider ‘home services’ packages.

Annex 4

An Innovative Systemic Change? - Micro-CHP, Energy Services and Smart Metering

Technological Innovation

Traditional CHP for domestic premises uses a relatively large CHP plant to supply heat through underground pipes to hundreds or thousands of homes. The scale of commercially available technology has declined to the point where installations suitable for the heat load of individual small commercial premises have been demonstrated. But equipment suitable for individual homes is not commercially available.

New technology, micro-CHP, developed by a number of companies around the world, now offers the prospect of household scale devices for the first time. Most technologies use a Stirling engine (external combustion engine). For typical domestic premises they are sized to produce 1 kW of electricity and 5 kW of heat. Larger sizes of 3 kW_e are more likely to be suitable for large houses and SME premises. The whole unit effectively replaces a domestic boiler, but also generates electricity, either for use on the premises or for export.

There is considerable confidence amongst manufacturers that the technology is now 'close to market' and that it can be cost effective, if sold into volume markets. At least one company plans field trials starting in 2001, with a view to full commercial launch in 2003.

Economics

A micro-CHP unit is expected to provide heat at efficiency equivalent to that of a good modern boiler. The economic and environmental benefit derives from generating power. Because of the associated heat load, this can be done with a high marginal efficiency, typically more than 80% - far higher than is possible with a centralised power plant.

The economics will depend upon three factors:

- the annual power generated,
- the value of that power, and
- the capital cost of the system compared to the boiler it substitutes.

In a typical domestic property, a micro-CHP system is expected to generate approximately 2500 kWh annually. However, actual generation will depend on the heat demand of the house. It will be greatest in large, older buildings with poor thermal insulation. This implies that, if commercially successful, micro-CHP may have a significant role in households suffering from fuel poverty. On the other hand, in new homes of high thermal performance, the heat load is low and the economics of micro-CHP will be worse.

The value of the electricity will depend upon the time that it is generated. Because the system operates when the building requires heat for space or hot water, the electricity output is expected to be well correlated with peak electricity demand. In other words, power output is likely to be at times when it has a high price within the wholesale electricity market and therefore a high value to suppliers. Whether this value can be captured by the household will depend on commercial, regulatory and metering arrangements. Assuming that the average value is 6.5 p/kWh (the typical domestic price), the annual electricity output has a value of approximately £160, i.e. about half the typical domestic electricity bill.

Provided that micro-CHP systems can be manufactured and installed (in volume) at a price of a few hundred pounds greater than a boiler the economics are therefore good for most homes at the point of boiler replacement. For the 5 million older, solid-walled-homes, we expect the economics to be very attractive.

An early niche market may be small commercial premises that have significantly higher heat and power loads than homes. Larger systems are likely to be cost effective in these cases. In some cases, they also have a less peaked demand for heat, so that the load factor of the system will be higher. The economics are therefore likely to be somewhat better than in many homes. It is a significant market – many hundreds of thousands. On the other hand, the market size is much smaller than the domestic sector, and more diverse, so it is will not support the same scale of operations.

Potential National Benefits

If micro-CHP were to become the normal choice for a domestic heating system, the impact on the energy system would be large. If installed in 20 million homes it would generate about 50 TWh annually, i.e. approximately half of the domestic sector demand or 15% of the national demand.

The potential carbon savings are also significant. Compared to installing a new condensing boiler, we estimate the emissions savings are approximately 0.25 tC annually for a typical system (assuming the current power mix is displaced). The potential national savings might therefore be 5 MtC annually.

Benefits on this scale will not be obtained quickly. They will require first a demonstration that the systems work effectively, then the development of a major manufacturing and installation industry, and significant changes to distribution networks.

However, even by 2010 we expect that the electricity output and emissions savings could be substantial. And, because the economics are best in the homes with the worst insulation, micro-CHP might also play a key role in the fight against fuel poverty.

Implementation Issues – Regulatory and Installation Innovation

Some immediate issues need to be addressed before the technology can be deployed effectively. There is broad agreement on the nature of these.³⁰

- Connection to distribution networks – this is currently very expensive as individual approval is required from Distribution Network Operators. The Embedded Generation Working Group recommended urgent attention to this and a Working Party of the Electricity Association aims to produce a draft revised connection standard by the end of this year. This will need to allow ‘type approval’, i.e. for approved designs to be connected without individual inspection.
- Charging regimes for exported electricity (‘spill’). In the long term, metering advances may allow two-way half-hourly metering (see below) so that spill can be sold into electricity wholesale markets in the same way as by any other generator. Currently costs make this unattractive, so alternative arrangements are required to ‘trade’ the power exports. The most promising route is use of a micro-CHP ‘customer profile’ in the electricity settlement process, under which an estimate of the generation profile of micro-CHP is used. This should enable users of micro-CHP to be paid for the value of the electricity generated without complex metering.
- Installer skills and support. The gas installer community is dominated by SMEs and sole traders and tends to be rather wary of new technology. This has been an issue with other new technology, notably condensing boilers. Micro-CHP is a more radical technology – installers will need to be skilled in electricity as well as gas and water. There is already a shortage of registered gas installers and an ageing profile. There is therefore a serious challenge for awareness raising and training if large numbers of micro-CHP systems are to be installed.

Integration with Energy Services – Market Innovation

The costs of a micro-CHP system will be higher than a boiler. Although the price difference may fall over time, some differential is likely to persist, as the system is inherently more complex than a boiler. The majority of boiler replacement is done as a ‘distress purchase’ when an old boiler fails. It is often an unforeseen and unwelcome call on scarce capital. The priorities for the householder are speed of installation and least cost, not longer-term energy efficiency. There is likely to be consumer resistance to micro-CHP on these grounds.

A more probable route to market for most customer groups is via leasing. From the customer perspective this would have the added attraction of reducing the initial payment. It would also give greater security that the system will be maintained, which might be important for a new technology.

³⁰ see, e.g., papers to ‘Domestic CHP – Making it Happen’ Seminar at Department of Trade and Industry, July, 2001.

Leasing of energy conversion equipment is potentially consistent with an energy services approach. If the micro-CHP system supplier is also the energy supplier (gas and electricity), then the consumer is essentially buying heat and power, rather than separate purchases of gas, electricity, a boiler and maintenance servicing. Whilst this is not 'energy services marketing' in its purest form of selling comfort and illumination, it is a big step in that direction. Micro-CHP leasing therefore potentially offers a significant opportunity to kick-start innovation in energy markets.

Fuel poor customers are not the most obvious target market for most innovative technologies. But micro-CHP may prove different, although it would need to be carefully tailored to ensure it was appropriate for vulnerable households. If the technology was acceptable and gave benefits in these households, it might prove very attractive for some of these households as the potential for bill reduction is larger than with even the most efficient boiler. The technology also has attractions for Government's objectives in this context. Ending fuel poverty for the poorest households living in large solid-walled houses by insulation and central heating alone may well be prohibitively expensive. Micro-CHP may well offer a cheaper option.

The Role of Metering – Knowledge Innovation

Although early deployment of micro-CHP will probably rely on 'profiling' to deliver some of the benefits of peak power production to suppliers and their customers, this may not be sustainable in the long-term. With large numbers of generators operating in the distribution networks, it may not be acceptable for their output to be estimated in this way.

Ideally, to be fully included in wholesale electricity markets, the power output should be metered in the same way as for larger generators, i.e. half-hourly. At present this appears to be uneconomic. However, smart metering is developing rapidly and may be economic at this scale of operation within a few years. The prospect of such a large market needing improved metering may increase commercial interest, and therefore micro-CHP may act as a catalyst for smart metering in the home.

The benefits should then include ensuring that households get the full value of the benefits that flow from generating at times of peak demand. But there are wider possible gains. Smart metering may involve not only providing half-hourly readings for system settlement. It could also give households far more information about their power (and gas) use. Coupled to other ICT advances this might have benefits as broad as:

- real time information on the price of electricity and gas,
- expert analysis of changes in demand to identify problems such as system malfunction or inefficiency,
- providing infrastructure for new renewable technologies such as building integrated photovoltaics, and
- remote control to allow 'moveable' loads such as freezers to be switched off at times of the highest demand.

Metering advances catalysed by micro-CHP might therefore begin an era of 'knowledge economy' energy systems in the home.

Conclusions

1. Micro-CHP is a technology with a very significant economic and environmental potential.
2. If the benefits are to be realised, development is needed in electricity system operations, commercial arrangements and installer skills
3. The technology chain may be most effective if there is wider system innovation incorporating energy services marketing and new metering technology.

Annex 5

Energy Efficiency Commitments - Revision to a Supplier Cap Mechanism

Introduction

The Energy Efficiency Commitments (EEC), formerly known as Energy Efficiency Standards of Performance (EESoP) form the largest single component of the Government's Climate Change Programme in the domestic sector. Their effectiveness is therefore critical to the Programme.

The system has operated in the electricity industry in England and Wales since 1994 and in Scotland since 1995. It was extended to the gas sector in 2000. Ofgem sets the level of EEC, and enforces its operation. Under the Utilities Act 2000, the legislative base was revised so that, in future, Ministers will take responsibility for setting the level and general principles, although Ofgem will retain oversight and enforcement roles. Ofreg sets and operates a similar system in Northern Ireland.

EEC originally operated as a levy. The PES supply businesses held monopoly franchises for small customers. The level of EEC was set at £1 per customer per year, as an allowance in the supply price control. Ofgem (originally OFFER) set targets for the energy saving to be achieved with the funds levied in relevant customers (now households only), approved projects and monitored their delivery. The level of EEC was raised to £1.20 per customer per year in 2000, to allow for the effects of inflation since the beginning of the schemes. With the addition of gas, this broadly doubled the size of the schemes from £25 million annually to £50 million annually.

With the onset of the fully competitive market in 1998 and the removal of price controls, the operation of a levy through the electricity supply businesses has become unworkable. From EEC-3 onwards (April 2000), obligations have been placed on all supply businesses and as energy saving targets only – no levy is set. Current targets are set at a level Ofgem believes can be delivered by suppliers spending £1.20 per customer per year, but there is no requirement to spend any given level, just to deliver the energy saving targets. Of course, it is expected that, in a competitive market with obligations on all suppliers, the costs of the obligation, like the costs of any other licence requirement, will fall ultimately on the customers.

Ministers have indicated that EEC-4, which is to operate from 2002 to 2005 will be substantially larger, at a level requiring notional expenditure of £3.60 per customer per fuel per year. This will require significantly enhanced programmes. Penalties for non-compliance will be those applying to breaches of licence conditions. One of the objectives of such an enhanced obligation is to drive energy efficiency in to the heart of the business operations of the gas and electricity suppliers, and to encourage their delivery through energy services approaches.

EEC was originally a requirement of the regulator and a levy based mechanism. However, it is now a 'delivery obligation' on the supply business, not a levy, and Ministers set it, subject to parliamentary approval. In order to make EEC more market-based, future obligations and/or their delivery will be tradable between the obligated suppliers. In all these senses, EEC is the domestic sector demand side equivalent of the Renewables Obligation.

Development of EEC towards Capping

The introduction of more market-based aspects to the policy instrument has stimulated discussion of the relationship between EEC and the Emissions Trading Scheme (ETS). Because EEC has social policy objectives in the reduction of fuel poverty, it would be inappropriate for EEC obligations to be delivered by projects outside the domestic sector. However, there seems broad agreement that, subject to appropriate safeguards, over-achievement of EEC obligations should be encouraged by allowing carbon savings from any over-delivery to be traded in the ETS.

Discussions of trading have highlighted that EEC is a 'project based mechanism', that is the obligation operates through the supplier having to deliver (or buy delivery of) projects saving energy up to a specified level. However, this is not required by the primary legislation, which allows a wide scope to the form of the legal obligation. The Government could choose to set EEC as a 'cap mechanism', i.e. require energy suppliers to demonstrate that they are delivering energy efficiency by showing that their customers' energy consumption is falling by a prescribed amount annually (or at least rising by a given amount less than the assumed baseline).

Implications of a Cap Mechanism for the Supply Market

The cap mechanism would have to operate on 'energy use per household' rather than on 'aggregate energy supplied' to prevent it acting as a disincentive to customer acquisition and therefore as a barrier to entry to competition.

In principle, the cap and project based approaches can be designed to give equivalent outcomes. Provided the business as usual energy use baseline is known, a cap can be set at a level to require precisely the same level of energy efficiency activity as a project based target. Trading can be allowed between suppliers in both cases (including between different fuels, if equivalence rules are set). The cost to suppliers, benefits to customers and carbon emissions reductions can, in principle at least, be achieved either way.

However, there are some important differences. The effects of a cap on market participants depend on the cap distribution. The fairest approach would appear to be a uniform cap of the same value of 'energy use per household' on each supplier, rather than 'grandfathering', which would reward past inefficiency. Modifications might be made to adjust for real and justifiable differences (see 'practical issues' below).

The overall effect on supply business strategies would be to place energy use per customer into the mainstream of planning, as it would be a fundamental constraint on business activity. The cap would be a clear statement by Government that future profits cannot be expected by increasing kWh sales per customer.

A uniform cap would give suppliers an incentive to deliver their obligations by two broad approaches:

- improving the energy efficiency of their own existing customers, or
- shifting their customer market towards customers with lower energy use.

The former is the only strategy in EEC at present. The latter raises important new issues. It would give suppliers an incentive to target smaller houses, more modern houses and lower-income households. They might do this either simply by redirecting marketing effort or by changing towards more progressive tariffs that reward lower energy use, or both.

The possible effects tariff changes would need to be very carefully investigated, especially in the context of groups more at risk of fuel poverty. High consumption households would pay more. At first sight, the equity effects seem to be broadly positive. Most fuel poor households have lower energy bills than average and therefore would tend to gain. However, some high energy using, poor households might be losers.

One other effect would almost certainly be to reduce competition for supply to high energy using households until tariffs were rebalanced. However, this seems preferable to the current situation where it is the poorest households that have received the least benefits from competition. The requirement on licensed suppliers to offer terms to all households would be retained.

There would be no incentive to undertake energy efficiency work for other suppliers' customers, in contrast to the current arrangements. More seriously, there would be a strong incentive for suppliers to gain customers who had recently had energy efficiency work undertaken on their properties by competitors. This would produce a matching disincentive to undertake the work in the first place. In a very liquid market, customer capture would be the preferred strategy for individual suppliers, even though it is a 'zero sum game'. Both of these effects could be avoided by transferring the credit for energy efficiency work already undertaken at the point of customer transfer. This would have the effect of tightening the cap on suppliers acquiring customers who had already benefited from EEC measures. More importantly, it would provide suppliers with a customer retainment incentive to undertake energy efficiency work, and thereby further incentivise energy services arrangements.

Advantages

A cap mechanism arguably has the following advantages:

- it gives greater certainty to Government that the mechanism will achieve its principal environmental objective, carbon emissions reduction, as this is associated with energy use, not energy efficiency projects undertaken,
- it would incentivise energy efficiency projects being undertaken with maximum effectiveness, rather than simply minimum cost, as the supplier is interested in the ongoing performance,
- customer average energy use would become a mainstream business issue for suppliers, whereas the project mechanism has historically resulted in marginalization,
- it provides a stronger driver for suppliers to invest and innovate energy services approaches,
- incentives to promote increased customer energy use, e.g. sales of energy intensive products such as air conditioning, would be removed,
- the requirements for project approval and monitoring would be removed.

Disadvantages

The potential disadvantages might be:

- a risk that suppliers will attempt to deliver targets through other means than energy efficiency programmes and therefore,
- a requirement for changes in customer switching rules or credit for 'old suppliers' at the point of switching, for this to be an effective mechanism,
- the need for accurate baseline projections if the targets are to be both realistic and challenging,
- greater uncertainty for suppliers, as there is no *a priori* guarantee that any level of energy efficiency activity will deliver the obligation,
- consequently a higher risk that companies will under perform and accept the risk of penalty,
- greater risk to the social objectives of EEC as there would be no constraint on the households in which energy efficiency work was undertaken and suppliers might have an incentive to discourage benefits being taken as comfort,
- loss of a monitoring system to identify projects undertaken,
- no incentives to undertake energy efficiency work outside customers.

Practical issues

The practical issues involved in implementation would be different for a cap mechanism. At first sight the more extensive approval and monitoring provisions for a project-based mechanism might seem more problematic. However, these have been solved - they already exist in the regime developed over time by Ofgem and its contractor. Changing to a cap based mechanism would raise different issues, and therefore, like all change, difficulties. These might include:

- how to set the caps for different fuels,
- allowance in the cap for suppliers with different levels of customers using electricity as the main heating fuel,

- allowance for fluctuations in fuel use due to the weather (these exceed any plausible annual reductions), e.g. by banking and borrowing or weather corrected energy use,
- allowance for justifiable regional variations in energy use,
- the treatment of multiple-metered properties and avoidance of perverse incentives to sub-metering,
- perverse incentives to purchase housing voids,
- treatment of customer movement with any year,
- enforcement and the use of any penalties incurred (in the absence of the equivalent of the buy-out provision that exists for the Renewable Obligation), and
- in the gas sector it would require that individual customer meter readings were aggregated for each supplier and used as the basis for measuring obligation delivery. This is not currently done for charging, although there seems to be no fundamental reason why it should not be done.

Given the range of issues raised, it is too early to identify whether the 'cap mechanism' option is preferred for EEC after 2005.