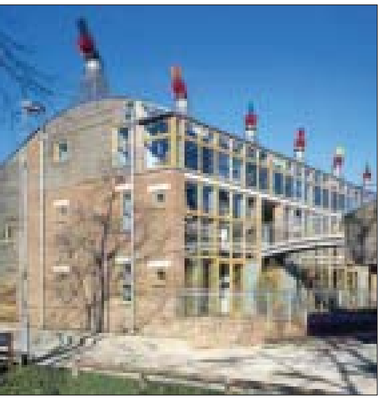
Achieving the 40% House scenario



The policies that will deliver a 60% reduction in carbon dioxide emissions in the residential sector involve a wide range of decisions and decision-makers. A market transformation approach is outlined as a possible delivery mechanism.

9.1 The 40% House scenario

The 40% House scenario achieves a reduction of carbon dioxide emissions to 40% of 1996 levels at least by 2050 and probably by 2047 and contributes to all four Energy White Paper objectives. This is based on a host of initiatives to control energy use and carbon emissions in this sector, resulting in the following changes:

- electricity consumption in lights and appliances has been reduced by nearly half, to 1680 kWh per household in 2050;
- all energy services have increased, per person (more warmth, hot water, space and access to appliances);
- the standard of new build means that homes have close to zero heating requirements from 2020 onwards. The average rate of construction has been increased by a third to 220,000 pa, so 10 million homes are built between now and 2050;
- about 87% of today's houses are still in use in 2050, but only those that can be refurbished up to a standard equivalent to 2004 new build;
- demolition is focused on the least energy efficient dwellings that are unhealthy to live in. The rate has increased from 0.1% pa of the housing stock in 2003 to 0.25% pa in 2050, by which time it will take only 400 years to replace the stock;
- there is an average of nearly two LZC technologies per house by 2050 and the housing stock as a whole is producing more electricity than it is consuming;
- national grid peak demand has been lowered by up to 25 GW.

The targets set are challenging but feasible, if Government starts now, and 45 years provides a substantial period of time in which to achieve a major new trajectory for residential carbon emissions, even acknowledging the inertia of the housing stock. In reality, these targets are approaching the extreme end of the policy envelope: it would be close to inconceivable to plan for tougher standards on lights and appliances or more low and zero carbon technologies on this timescale. Higher demolition and construction could be possible – and higher construction rates were proposed in the Barker Review (2004) – but a higher rate of demolition was deemed to be socially unacceptable.

Finding: The target of a 60% reduction in carbon emissions by 2050 is achievable in the residential sector, but requires a strong commitment by many sectors of society. The 40% House can be achieved.

Finding: The level of energy services increases per person: the average individual is warmer, has more hot water, more space and access to more appliances.

The 40% House scenario is demanding and demonstrates the task to be faced if the UK is to achieve its commitment to mitigating climate change. It may be that a tougher target should be aimed for, because:

- more may be expected and demanded from the residential sector, to compensate for the greater challenge posed in areas like transport, where reductions of 60% are even more difficult to envisage;
- climate change is proving to be more of a threat than previously anticipated, so action and cuts are more urgent and should be stronger than 60% by 2050 (Hare and Meinshausen 2005, Hillman and Fawcett 2004).

The 40% House scenario demonstrates an appropriate basis for policy. It is recognised that different combinations of measures to the ones proposed in the scenario are possible, but any lowering of activity in one area has to be offset by more stringent standards elsewhere. For instance:

- if the number of demolitions is not as high, then tougher Building Regulations will be needed, eg getting to zero space heating

There will be more hot water, space, warmth and appliances per person in 2050 – but carbon emissions are reduced by 60%

demand in 2010, rather than 2020;
- if the full technical potential in lights and appliances is not met, or substantial demand from unexpected new uses occurs, then each home will need more than two LZC technologies.

Finding: The individual targets in the 40% House scenario can be traded off against each other (more of one, less of another), but the options are limited.

9.2 Constraints

All of this could be achieved, despite the following conservative assumptions made by the project:
- The carbon emissions factor for electricity does not change after 2030 – it does not even include the effect of any electricity exported from the domestic sector, because of uncertainty about what is happening elsewhere.
- There are no major technological advances, just the strong development of known technologies, such as light emitting diodes, vacuum insulated panels in fridges and freezers, photovoltaics, micro-combined heat and power.
- The stock grows from 23.9 million properties in 1996 to 31.8 million in 2050 because of population growth and a diminishing household size (down to 2.1 people per household) – factors which are not amenable to policy intervention. Other things being equal, this would produce a 33% increase in energy demand and an immense policy challenge. This is one area where energy policy has to cope with the consequences and prepare for such an increase.

The 40% House scenario has numerous implications for other parts of society and the economy. These are recognised as of importance, but not included within the boundaries of this project. There is no intention of shifting the problem from the residential sector elsewhere, but the energy system is an integrated whole, so affecting one part will inevitably have implications in other places.

Finding: Over time, changes in population and declining household size result in more households and hence could lead to up to a 33% increase in energy demand, if nothing else changes. This demonstrates the scale of the challenge of achieving a 60% reduction.

Finding: The 40% House scenario is achieved, despite cautious assumptions on household numbers and the carbon intensity of electricity. The savings will be greater if these assumptions are too conservative.

9.3 Policy focus

The main focus of the project has been on product policy, using a market transformation strategy. In the past, housing has not been considered a traditional product, partly because it is not a commodity that can be moved around, although building components and technologies can. However, the European Commission is increasingly looking at making policy on buildings more consistent across Member States, for instance through the Energy Performance of Buildings Directive (EPBD). The novel approach taken in this project has been to investigate how market transformation may be extended to houses in order to promote a more rapid turnover of the housing stock and the development of ultra-low carbon technologies and lifestyles (Section 9.9). This requires a combined energy and housing strategy, focused on carbon mitigation. This moves away from the present suite of policies, which encourage the continuing use of the existing stock even if energy-inefficient.

Product policy has to be a priority, especially when prices are rising as a result of resource scarcity and political pressures or there is a focus on raising prices through taxation. Consumers need information to help identify which products to buy in order to use energy efficiently and cut costs. The scale of the challenge – and the increasing concerns about climate change – means that policy should aim at certainty of outcome. For this reason, there is a strong emphasis on regulation, for instance Building Regulations and minimum standards for new appliances and existing houses.

Certainty of outcome requires that policy shifts more from reactive to proactive mode: ensuring the right products come to market, rather than trying to minimise the impact of harmful equipment once it is being manufactured. Unless a genuine concern for the environment envelopes industry, Government may have to take stronger measures to protect consumers and the planet.

Another component of a proactive policy is education of the public about the seriousness of climate change and the vital role of personal responsibility. This is an essential backdrop to the 40% House scenario, so people begin to learn about the need to control their energy consumption and carbon emissions, and recognize that this can be achieved without a drop in standard of living and, probably, with an enhanced quality of life.

Finding: A combined UK energy and housing strategy covering all energy use in the home is required, with the main criterion being to ensure the best contribution to carbon mitigation.

Finding: A market transformation strategy for housing represents a novel application and identifies the way policy can be proactive, rather than reactive.

9.4 Timescales

This report is primarily concerned with the target of a 60% carbon reduction by 2050, but this date should be seen as part of a continuum, with the necessary carbon savings being long-lasting, permanent and irreversible. By 2100, the UK will have to reduce carbon emissions by 80% in order to achieve atmospheric carbon dioxide concentrations of 550 parts per million (RCEP 2000), or even more if recent claims about the likely scale of climate change are correct. Whilst there are currently no formal commitments over this time period, the scale of reductions is in line with the philosophy of contraction and convergence (GCI 2001). A prompt, decisive introduction of the policies outlined in 40% House scenario would help towards the achievement of a low carbon society in the long term as well as improving the chances of meeting existing targets. For the latter, improved standards for lights and appliances are particularly important, as turnover is already rapid and energy standards are undemanding.

Finding: A key policy objective is to make savings that are long-lasting, permanent and irreversible, that contribute to carbon reduction targets both before and after 2050.

Finding: An early requirement of the energy and housing strategy is to identify the timescale for policy action, so that future targets are not jeopardised by a failure to act soon. The timetable is tight and the aspirations substantial.

9.5 Opportunities for action: the housing stock

The slow turnover of the housing stock means that improved energy efficiency is limited by opportunities in existing dwellings and the rate of new construction and demolition. The biggest benefits come from replacing old, energy inefficient properties with new, low-carbon dwellings, if on a sufficient scale. The rate of demolition is an important component of the 40% House scenario, although this is a complex issue given the UK's architectural heritage and the fact that 70% of homes are owner-occupied.

9.5.1 Historic buildings

Many of the buildings that form the historic centre of UK towns and cities were originally houses but are now occupied by the offices of lawyers, accountants and doctors. These are no longer part of the housing stock, though they are often part of the image people have when discussing the country's architectural heritage. There are, however, 1.2 million dwellings in conservation areas and about 300,000 individual residential buildings listed as architecturally important. This 5% of the housing stock is treated as sacrosanct and not included in any plans for demolition; it represents about a quarter of the dwellings built before 1919. Hence, the majority of homes that are approaching 100 years of age are not protected under either of these pieces of legislation, at the moment. They have not been identified as part of the UK's 'official' architectural heritage. By implication, three-quarters of pre-1919 homes could be demolished if deemed unhealthy and incapable of providing affordable warmth.

Finding: Preservation of the architectural heritage focuses primarily on 25% of the pre-1919 housing stock.

9.5.2 Refurbishing the existing stock

The main factor determining decisions about the demolition rate is the extent to which the existing stock can be improved. In the 40% House scenario, existing homes that are still occupied in 2050 (21.8 million dwellings) have all been brought up to the standard of current Building Regulations for new building (ie a SAP of approximately 80), with an average heating demand of about 9,000 kWh pa. At present, only about 9% of the stock has a SAP of 70 or more.

The policies to achieve this will be based on the Building Regulations – which already cover major improvements – and on existing policies, such as the Decent Homes standard for much rented accommodation. A substantial upgrade in the effectiveness of these policies is needed, combined with local authority action on the worst housing and new initiatives such as financial incentives through stamp duty rebates on investments to reduce the carbon emissions from a building. The rebates should be linked to a proportion of the investment, not to a percentage of the duty paid as this would unduly favour the richest householders.

Finding: The aim is to achieve the maximum reduction through retrofitting the existing stock, to minimise costs and social disruption.

Finding: The target of getting 21.8 million homes up to an average of SAP 80 (heat demand of 9,000 kWh pa) by 2050 will require substantial, forceful new policies that need to be implemented as soon as possible.

9.5.3 Demolition

There is a direct relationship between demolition levels, the resultant lifespan of the average dwelling and the energy use in the whole stock. Present levels of demolition (20,000 pa) are demolishing barely 0.1% of houses each year, implying a stock lifetime of nearly 1,300 years (Table 9.1). Energy demand from the total stock will continue to rise if the amount of energy used in new buildings (for growth in household numbers) is not offset by reductions in the existing stock through demolition.

Table 9.1: Housing stock demolition rate, lifetime and energy consumption, UK

Annual demolition rate	*Lifespan (years)*	*Average SAP, 1996*	*Average SAP, 2050*	*% over 100 years, 2050*	*Energy change by 2050*
20,000	1300	44	66	31	+6%
150,000	250	44	77	25	-12%
234,000	120	44	84	19	-24%

Source: UKDCM

Under the 40% House scenario, the demolition rate increases from 20,000 pa now to 80,000 pa in 2016 and stays at this level until 2050, giving a total demolition over the whole period 2005-2050 of 3.2 million properties. By this stage, the demolition rate will have increased to 0.25% of the housing stock, taking 400 years to replace the 2050 stock of houses. The majority of homes demolished would have a low SAP (for instance there are currently 3 million below 33 SAP points), or be deemed unhealthy under the Housing Health and Safety Rating Scheme. Savings beyond those in the 40% House scenario would come from increasing the demolition rate further to 150,000 pa and would reduce the notional lifespan of the average building to 250 years. To get down to 120 years, demolition would have to rise to 234,000 pa. The latter would enable energy consumption for space and water heating to be reduced by 24% and the average SAP to rise to 84.

Finding: The current demolition rate needs to be increased fourfold, targeted at the most inefficient and unhealthy homes.

9.5.4 New construction

A key focus of the 40% House scenario is on the standard of construction – both as designed and its performance in practice – and on the size and type of dwelling. By 2020, the standard in the Building Regulations results in homes with nearly zero space heating demand.

The rate of new construction in the UK under the 40% House scenario is an average of 220,000 pa from now to 2050. This is 38% above the current rate of 160,000, but lower than the annual figure of 242,000 recommended at least for a period to bring house price inflation in England down to 1.8% pa (Barker 2004). Barker did not consider the rate of demolition, therefore the rate of construction may need to be even higher than the one proposed under the 40% House scenario.

In addition to the quantity of new homes required to reduce pressure on house prices, there are several other important interlocking issues related to new construction, which are beyond the remit of the project. These include whether the homes (and related jobs) should be moved out of the South East, the relative importance of different tenure groups and whether more social housing should now be constructed.

In recognition of the growth of single-person households, the 40% House scenario assumes that much new construction is of smaller homes: the average new dwelling is 74m² by 2050. This links to the quantity and density of construction (Table 9.2). If the space per person is kept the same, the projected 33% increase in household numbers only results in a 15% increase in total residential floor area. Whereas, if the size of the average dwelling is maintained, then the 33% increase in household numbers does result in a 33% increase in total floor area, with 14% extra space per person.

The Government is already encouraging development of denser housing. From March 2005, it aims for 30-50 dwellings per hectare in London and the South East, South West, East of

Table 9.2: Effect of space per person on total residential built fabric

	Number of households (million)	*Size (m²)*	*Total residential floor area (billions m²)*	*People per household*	*Space per person (m²)*
1996	23.9	84	2.0	2.4	35
2050	31.8	74	2.3	2.1	35
2050	31.8	84	2.7	2.1	40

Construction of new homes must average 220,000 per year until 2050. By 2020 they use only 2000 kWh per year for heating

England and Northamptonshire (ODPM 2005). But this is still treating the dwelling as the main measure. There needs to be more recognition of the interaction between the space per dwelling, the space per person and the quantity of built fabric in total (including communal space), as the latter has implications for the amount of land that is needed for new housing construction.

Finding: The rate of construction is increased from 160,000pa to 220,000pa, with only 30% (3.2 million) replacing demolished houses; the rest is for new household formation. In total there are 10 million new homes.

Finding: The need for cooling is minimised in the design of new buildings (eg high thermal mass) and there are strategies to retrofit existing buildings (eg with shading grills).

Finding: The remit of the proposed energy and housing strategy covers location, tenure, size and density of housing developments over the next 50 years.

9.6 Opportunities for action: lights and appliances

Historically, the greatest increase in energy demand in the home has come from the acquisition of more electrical equipment – up 70% from 1970 to 2001 (Figure 1.2). The biggest threat to additional residential energy consumption, at least over the next decade or so, comes from the acquisition of more electrical equipment. There has to be a strong policy focus on lights and appliances, if the residential sector is to contribute to the 60% carbon reduction. However, much UK policy in this area is determined by the European Commission as these are traded goods that should be of a common standard. In the 1990s, EU policy was fairly rigorous and beginning to be influential, through the use of market transformation strategies. For some groups of appliances, notably refrigeration and washing machines, consumption declined. In the last few years, the Commission has become less interventionist, for instance relying on voluntary agreements with industry, rather than mandatory minimum standards. As a result, there has been less constraint on demand and electricity consumption is rising.

Finding: Unless the present rate of growth of electricity use in lights and appliances can be curbed and reversed, the 60% carbon reduction in the residential sector will be all but impossible. This requires the UK, together with other Member States, to focus on strong European policies, with immediate effect.

Finding: The rapid turnover of the stock of lights and appliances means that savings can be achieved quickly, once policy is implemented. This could, even now, contribute to additional savings to achieve the EU's Kyoto target for 2008-12.

In the last few years, there have been examples of manufacturers producing new designs and equipment that is particularly profligate in its consumption of energy – the plasma TV is a good example, as it has a power rating of 350 W in comparison with the 75 W TV that it replaces. The unnecessary high demand in digital set-top boxes is another example. In certain sectors, particularly consumer electronics, a reactive policy approach cannot keep pace with the evolution of new technology. The introduction of eco-design requirements under the European Energy-using

Products Directive would encourage manufacturers to place greater importance on energy efficiency and demand reduction as part of product design, helping to control the introduction of profligate appliances.

Finding: Manufacturers must be encouraged to view energy efficiency as a vital component of product design to prevent energy-profligate equipment appearing on the market. This could be achieved under the European Energy-using Products Directive.

Finding: Existing market transformation programmes, and forthcoming EU Directives, provide useful experience and the appropriate framework for tough reductions in residential lights and appliances.

Finding: To aid consumer choice, all energy-related products would have an energy consumption label, before being placed on the market.

9.7 Opportunities for action: space and water heating and low and zero carbon technologies

The 40% House strategy is to plan for the next generation of technologies for space and water heating as low and zero carbon emitters. Policy is dealing with the short-term by ensuring that gas-fired condensing boilers become the norm and the gas network is extended, but a longer-term view is necessary.

Low and zero carbon technologies include methods of generating electricity at the household level (photovoltaics, PV, and combined heat and power, CHP). Many of these technologies are not yet cost-effective and will need support to become so. Substantial development of existing technologies is required, for instance, considerable advances and cost reductions in both photovoltaics and micro-CHP.

At present, a significant number of households use electricity either for space or water heating, or for both. The use of electricity in the UK emits at least twice as much carbon dioxide per unit of delivered energy as gas in the UK. In the 40% House scenario, the use of electricity from the national grid in the home for space and water heating is minimised.

Finding: The LZC technologies could contribute about a third of the savings to the 40% House. They are a portfolio of building-integrated measures (micro-CHP, solar thermal, photovoltaics, heat pumps and perhaps some wind) and community heating either with CHP or fired by biomass.

Finding: 53.6 million LZC installations for the residential sector will stimulate new employment, both in their manufacture and installation.

Finding: This level of LZC installation will only occur if there is considerable support to ensure that the technological improvements are achieved, the cost per installation drops and that they can be financed.

Finding: LZC can provide 81% of the heat demand for space and water and all of the electricity used in the home, by 2050.

Finding: This transformation of energy demand in the residential sector has major implications for the utilities and particularly the electricity supply industry.

Finding: The preferred residential fuel may vary by region and by house type. In the 40% House scenario, the use of electricity from the national grid is at a minimal level.

9.8 Opportunities for action: peak demand

This project has examined the proportion of peak demand that comes from the residential sector and the extent to which this can be reduced, as a contribution towards maintaining integrity of the electricity supply. This is particularly important at a time when substantial capacity (coal and nuclear) is about to be retired from the system. This is not so much a carbon reduction strategy (though it contributes), more a component of the Energy White Paper aim to improve security of supply.

There are two ways in which peak electricity demand can be reduced through a focus on those uses that already contribute to the residential peak: first by installing and accelerating the deployment of known, efficient equipment, for instance light emitting diodes. Secondly by specifically designing new equipment with a lower maximum demand, which would generally contribute to lowering the peak. There are small additional savings available, for instance through fuel switching out of electricity for peak demand uses, such as cooking. Some of these – a return to gas kettles – may not match consumer preferences. When peak demand reduction is combined with the installation of equipment that produces electricity in the home (eg micro-CHP), the net effect is considerable. Under the 40% House scenario, UK peak demand is reduced by 25 GW in 2050, in comparison with a 2002 peak of 62 GW.

Finding: Residential energy policy can contribute substantially to lowering peak electricity demand and hence reducing the need for generating capacity and infrastructure, with considerable expenditure reductions and security of supply improvements.

Finding: The design and installation of lights and appliances can be optimised to reflect the need to keep peak demand low.

9.9 Market transformation strategy and housing

There is already considerable experience of the ways in which market transformation can work, successfully, with lights and appliances (Boardman 2004a, b). The same strategic approach, integrating a range of policies, would facilitate the implementation of the 40% House scenario. The main components of a market transformation strategy are labels, minimum standards, procurement, grants and rebates. Such an approach would form the basis of an overall UK housing and energy strategy.

9.9.1 Labels

A home energy label on its own will have minimal impact – there are too many competing factors affecting the way people choose where they live – but is central to a product policy approach. An accurate, complete national labelling system, with the information stored in a central database, is vital to a coherent housing strategy.

Currently few properties have any type of energy label and there is no consistent format or publicity. Consequently, the public, and policy makers, are unaware of the inefficiency of the properties they occupy and cannot differentiate the good from the bad. Labelling of individual houses is being incorporated into the Building Regulations (although compliance is poor) and in other policies such as the Home Information Pack, as a result of the Energy Performance of Buildings Directive. Neither of these cover all energy use in the home, which would be the ideal approach, particularly when future homes have zero heating demand and most of the energy used will be in lights, appliances and water heating. In many homes, the majority of appliances are incorporated into a fitted kitchen – a trend that seems to be increasing – and should be considered as fixed entities. In all cases, the label is based on a theoretical calculation – for instance, what would be required to achieve a defined internal temperature – rather than reflecting the bills and unknown lifestyle of the occupants. It is therefore a rough guide, but still one that allows for useful comparisons.

The Sustainable and Secure Buildings Act 2004 (the Stunell Act) enables the Building Regulations in England and Wales to cover the protection of the environment and facilitate sustainable development. This includes renewable technologies, two-way metering and fiscal incentives for energy efficiency measures. The Act also requires the Secretary of State to provide a report every two years on the change in the efficiency with which energy is used in buildings, the emissions of greenhouse gases and the extent to which own-generation is integrated into

Homes that are unhealthy and do not provide affordable warmth should be the target for improvement or demolition

the building stock. Local authorities have to keep supporting documentation.

Under the Home Energy Conservation Act 1995, the 400 local housing authorities have to provide annual reports on the energy efficiency of all the houses (no matter what tenure) in their geographical area. In this way, the whole country is covered. The HECA reports are, apparently, of limited accuracy at present (Smith 2000). One way to deliver the necessary focused action and clear reporting would be to upgrade the standard of the HECA reports, make them more sophisticated and use them as the basis for policy. This fits well with the requirements of the Stunell Act and could utilise the results from Home Information Packs.

Finding: For a comprehensive market transformation strategy, the dwelling energy label would cover all uses of energy in the home (not just space and water heating). The use of labels would be enforced and coverage of the whole stock achieved as quickly as possible.

Finding: The information from the label could be held in an address-specific database, for each geographical area, to provide a national policy resource. This would support local authority compliance with the Stunell Act and link to existing HECA reports.

9.9.2 Minimum standards – unhealthy dwellings

At the moment, there is no strategy to ensure a minimum level of efficiency for all occupied dwellings. There are still homes with a SAP rating below zero – a situation that was deemed virtually impossible when the scheme was devised – and 9% of properties with a SAP below 30 in England in 2001 (ODPM 2003a). Many of these are solid-walled properties, dependent upon electricity for the main fuel, the vast majority occupied by low-income families. The poorest people are purchasing the most expensive warmth.

The Housing Act 2004 introduces a new system for defining homes that are unhealthy or unsafe, called the Housing Health and Safety Rating System (HHSRS). This provides for cold homes to be included for that reason alone. The effectiveness of the HHSRS will depend upon the obligations placed on housing authorities to identify and act on unfit properties. The Building Research Establishment estimates that about 8% of properties in England are 'actionable' for one or more reasons (Nicol 2003). Whilst the HHSRS is mandatory, the action and funding may be discretionary, therefore it is difficult to predict the extent to which this new legislation will result in the removal of the worst houses from the stock, particularly in the short term. The legislation does, however, provide a strong potential force.

It is not suggested that an unhealthy property has to be pulled down and certainly not when it is valued highly for its architectural heritage. The requirement is for improvement to a greater level of energy efficiency so that it provides affordable warmth. The upgrade should be substantial so that it does not require further work as standards rise in the future. This could be delivered by the individual housing authorities, through a rolling target that combines average improvements with the minimum standard: a 10% improvement by 2010, 20% by 2020 and so forth.

Finding: A primary objective of the proposed energy and housing strategy is to define a minimum standard of thermal performance and ensure that it is rigorously and quickly enforced. The new Housing Health and Safety Rating System provides the mechanism for this, as long as funds are available for local authorities and utilised.

9.9.3 Minimum standards – Building Regulations

The Building Regulations define the minimum standard of heat loss in new buildings and major conversions. The next upgrade in 2005 is likely to be framed in terms of carbon emissions per m^2, rather than U values of individual components. The 40% House scenario assumes continuing, substantial improvements in the Building Regulations at regular intervals, including the installation of LZC progressively, in both existing and new dwellings. From 2020 onwards, there is close to zero heating demand.

Research to establish the energy efficiency gains achieved in practice from the current Building Regulations – post-occupancy evaluations – together with better analysis of the U values ascribed to individual construction methods would both go towards ensuring that the standards are accurate in their consumption predictions (Olivier 2001). At present, new houses are often built in ignorance. Poor design details and construction methods can annul many of the benefits of the added insulation. Thus, enforcing the Building Regulations, both through the standard of what is built and in their application to the existing stock, is a major challenge. It requires:

- a better-educated public to demand good quality advice and service, and to know when their plans might interact with the Building Regulations;
- more training in the construction industry (including small builders) to ensure that they are scrupulous at informing the public about the required standards and that what is promised is actually delivered;
- more resources for local authorities, so there are more and better-trained building inspectors and less reliance on builders self-certificating;
- greater emphasis in the Building Regulations on performance criteria, for instance pressure testing, to ensure that the whole building achieves the defined and designed standard.

The standard of new accommodation provided by social landlords – local authorities and housing association – will improve with the Building Regulations. The homes of low-income households should be disproportionately efficient and higher than specified in the Building Regulations. This is already the situation in Scotland where new housing association dwellings have to obtain a SAP rating of 85-90, which is above the present English Building Regulations. In Wales, sustainable development is a legal requirement of all policies.

The Energy Efficiency Partnership for Homes has already introduced an annual training programme for 45,000 people, to prepare for the anticipated, mandatory installation of condensing boilers in the 2005 Building Regulations (EEPH 2004). Each successful trainee gets a City and Guilds certificate. This process should be repeated to include low and zero carbon technologies. If, under the 40% House scenario, the Building Regulations require the installation of technologies such as solar hot water heaters, then the building industry will be required to upgrade their skills on a regular basis.

Finding: In order to provide affordable warmth, despite higher fuel prices, the standards of new construction of social housing would be to a higher standard than those for the general public.

Finding: To ensure that the expected savings are achieved, the Building Regulations would incorporate, or be redefined as, performance standards.

Finding: To aid the deployment of LZC technologies, they could be specified in the Building Regulations, increasingly, for both new and existing dwellings;

Finding: If an ongoing strategy for Building Regulation standards is identified, even in the most general terms over the next 40 years, the extent of improvements can be identified, appropriate technologies prepared and mandatory training provided for installers and the construction industry.

9.9.4 Procurement and exemplars

A clear policy focus on procurement and the testing of low and zero carbon techniques (in preparation for new Building Regulations) is required. Demonstration projects in the UK and experience in other European countries would clarify any lessons and causes of concern surrounding new approaches and technologies, such as ever-wider cavity walls. To date, there are only a few advanced demonstration schemes, such as BedZED and the York housing development being constructed as a test for the likely 2005 Building Regulations (Lowe et al 2003).

New building-integrated technologies are currently supported by £60 million pa in grants through Clear Skies to encourage the take-up of more efficient new equipment, for instance solar thermal, photovoltaics and heat pumps. Most of the initial grants have been used for solar thermal installations, as the individual grant level is inadequate to encourage the more advanced and expensive technologies. Really innovative technologies, such as integrated wind turbines, are not yet considered. This scheme provides token support for new ideas rather than a developed procurement programme.

Finding: Knowledge of the combined effects of demand reduction and building-integrated low and zero carbon technologies would be increased substantially if each local authority had at least one demonstration development, like BedZED, as soon as possible.

9.9.5 Grants and rebates

The traditional role of grants in a market transformation strategy is to grow the market for new technologies by reducing the unit cost. This should be a limited initiative, until demand for the product is secure and it is manufactured by several companies. With housing, however, existing grant schemes are used principally to improve the worst housing, mainly for the fuel poor occupants – not to boost demand for a new technology. The effect of most of these grants is to improve the energy efficiency of the property by about 20 SAP points. The recent fuel poverty action plan sets the objective of raising properties to 65 SAP points in England (DEFRA 2004c), as fuel poverty is deemed to be unlikely above this level. In Scotland the target is 65-70 SAP points. The fight against fuel poverty is both a moral imperative and a legal requirement, but resources are scarce and there appears to be no strategic debate about the validity of insulating buildings that should, sometime soon, be pulled down. The present approach is fossilising the existing stock, albeit for humane reasons.

The rented sector suffers from the problem of 'split incentives' – it is the tenant that benefits from investment in energy efficiency by the landlord. This problem is particularly acute in the privately-rented sector, where there is a concentration of old, energy-inefficient properties occupied by low income households suffering from fuel poverty. In 2004, the Government introduced the Landlord Energy Saving Allowance (energy efficiency investments can be offset against tax), lower VAT on some energy saving measures and a Green Landlord Scheme. The net effect of these initiatives is difficult to predict.

The role of grants needs to be reassessed, in the context of a realistic approach to eradicating fuel poverty. As fuel prices rise, the numbers in fuel poverty will increase again, forcing the development of a clearer fuel poverty strategy. Meanwhile, there is a role for grants to the non-fuel poor, for instance to encourage greater energy efficiency through stamp duty rebates. The point of sale is a good time to intervene.

Finding: An energy and housing strategy would clarify the role of grants and the extent to which these are primarily focused on eliminating fuel poverty, as at present, and whether additional resources are also needed to encourage best practice, as in a traditional market transformation strategy.

9.9.6 Summary: the complete strategy

The net effect of policy today is a few initiatives which maintain the present housing stock, rather than transform it towards greater energy efficiency. The proposed energy and housing

Table 9.3: Main variables in 40% House scenario compared to 1996 baseline

Variable	*1996 – baseline*	*2050 – 40% House*
People and dwellings		
Population (millions)	59	66.8
Household size (people per household)	2.47	2.1
UK household numbers (000s)	23,900	31,800
UK rate of new construction (pa)	162,000	220,000
UK demolition rate (pa)	8,357	80,000
m^2 per person	34	38
m^2 per dwelling	84	84 (refurbished) 74 (new)
Building fabric		
Space heating demand (kWh per household)	14,600	8,300 existing 2,000 new
Ventilation rate (air changes per hour) for new buildings	3.5	0.5
Energy uses		
Internal temperature (°C) – zone 1	18.3	21
zone 2	17.3	18
Cooling temperatures	No air conditioning	No air conditioning
Electricity consumption in lights and appliances, including cooking (kWh per household)	3,000	1,680
Energy for hot water, kWh per household	5,000	3,400*
Supplying energy demand		
Gas boilers ownership efficiency	 69% 68%	 8% 95%
Electric heating ownership efficiency	 9% 100%	 10% 100%
Community heating with CHP and biomass ownership	0%	22%
Micro-CHP ownership efficiency (heat:electricity)	 0% 85:10	 21% (Stirling) 80:18 (Stirling) 20% (fuel cell) 55:35 (fuel cell)
Heat pumps ownership efficiency	 0% 300%	 9% 300%
Photovoltaics (electricity production) ownership	 0%	 30% (20m^2, 15% efficiency)
Solar thermal water heating ownership	 0%	 60% (5m^2)
Emissions factors electricity (kgC/kWh) gas (kgC/kWh)	 0.136 0.049	 0.1 0.049

Source: UKDCM

* net of solar hot water

strategy would develop a proper market transformation approach with clear, stated targets (Table 9.3). In the 40% House scenario by 2050, the 21.8m existing homes have been refurbished up to a high standard.

Finding: By 2050, the aim is for the average, existing property to have a SAP of 80 (the level of today's new build) and for there to be no homes with a SAP lower than 51 points (today's average).

Finding: A detailed, comprehensive market transformation strategy for all energy use in the housing stock could be a major delivery mechanism for the 40% House scenario. This would identify the contribution of individual policies, the target standards for specific dates and the role of different delivery agents.

In addition to the Energy White Paper, the starting point for this project was the Royal Commission on Environmental Pollution's 2000 report and its four scenarios (Table 1.2). The main differences between the RCEP scenarios is the extent to which demand could be reduced and then the way in which the resultant demand is met from varying combinations of renewables, nuclear and carbon sequestration. The carbon reduction achieved in the 40% House scenario comes from a combination of demand reduction (two-thirds) and the provision of building integrated low and zero carbon technologies (one-third).

The carbon intensity of the electricity from the national grid has been kept stable at the 2030 level until 2050. Further or alternative reductions could come from the energy supply system – there has been no assumption of carbon capture and storage (also known as carbon sequestration), seen by some as a necessary end-of-pipe solution to reducing carbon emissions, and no new nuclear. The supply mix has been kept at the 2030 level and the effect of the reductions in residential demand on carbon emissions per unit of centralised electricity have been ignored.

Finding: The 40% House scenario has demonstrated the substantial extent to which residential demand can be reduced through a coherent policy approach, without resorting to cleaner centralised electricity generation. Indeed, central capacity is reduced.

9.10 Other considerations

There are a number of considerations that underpin the development of a market transformation for housing which must be addressed to ensure full coherence and effectiveness of any strategy.

9.10.1 Responsibilities of local and regional authorities

The local and regional housing authorities have a major role in the delivery of housing policy and this could be reinforced. There are numerous individual policy activities and reports that influence the housing stock – Warm Zones, Housing Market Renewal, English Partnerships, Energy Efficiency Plans for Action, the Egan Review and Sustainable Building Partnerships – to name but a few. It has been beyond the scope of this project to examine the potential combined effect of all these initiatives, but one of the reasons behind the call for an energy and housing strategy is to ensure that these components add up to a coherent whole.

The devolution of greater, but flexible, responsibility to local authorities (whether regional or district) appears appropriate. The first study on Housing Market Renewal demonstrated that the local authorities, when given the freedom and resources, give priority to demolition of obsolete properties as a housing renewal strategy (Cole and Nevin 2004).

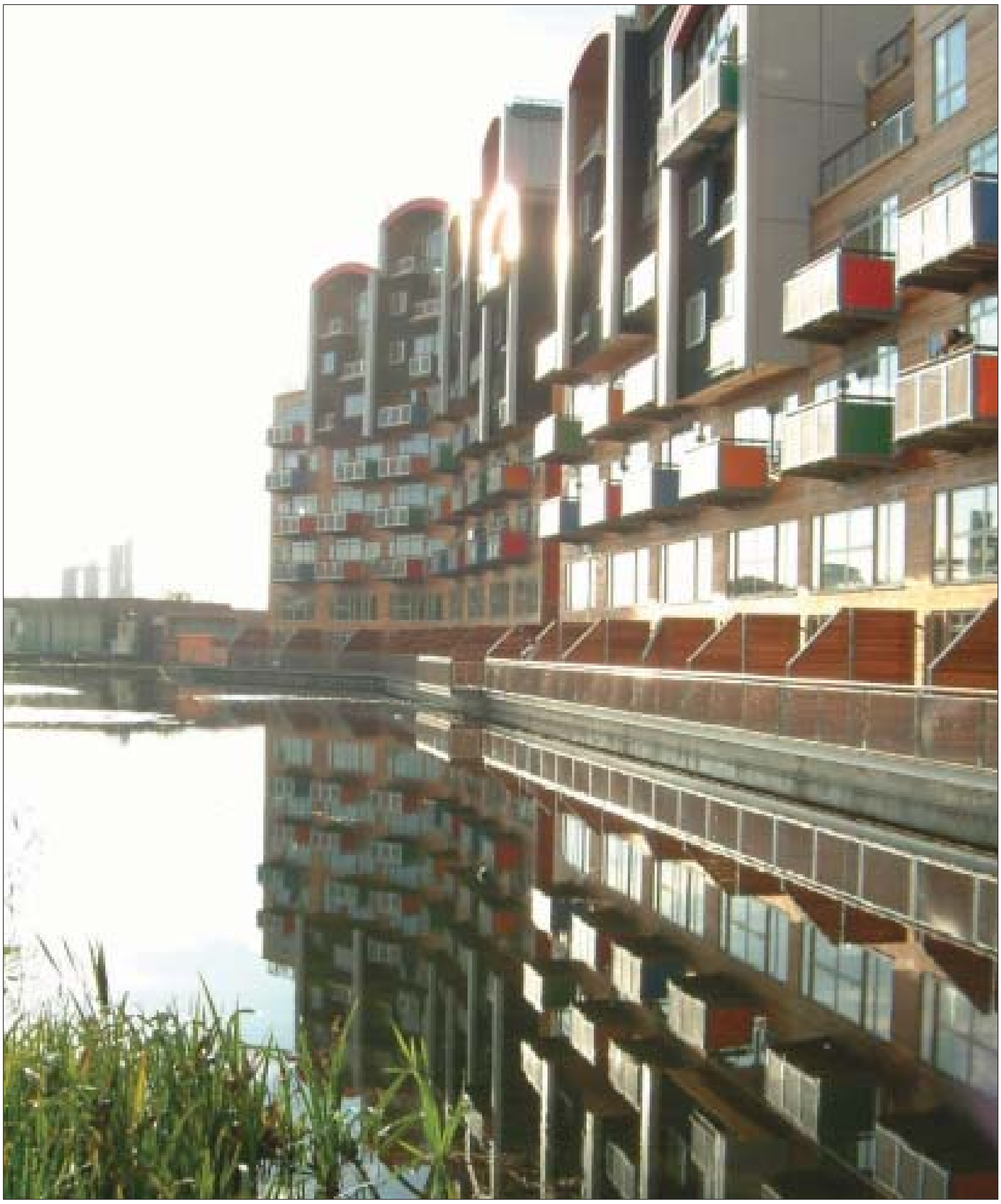
The new Regional Housing Boards are gaining a clearer remit, which will be defined further in 2005 (ODPM 2004i). They were established following the publication of the Sustainable Communities Plan in February 2003 by the ODPM, with the aim of improving regional planning for housing.

Finding: The devolution of responsibility to both regional and district housing authorities, if properly funded, represents an opportunity for a targeted approach to an energy and housing strategy, whilst recognising the need for flexibility.

9.10.2 Energy efficiency versus energy conservation

The trend is towards larger appliances (fridges and washing machines) and more housing area per person, increasing the demand for energy, sometimes in the name of energy efficiency.

Property developers need to design dwellings for smaller households



Energy efficiency is a relative term – in the context of the European Energy Label, it is defined as the demand for energy per unit of 'service', for instance the volume of a refrigerator or the weight of clothes washed. As the equipment gets larger, it is easier to achieve a high level of energy efficiency, which is the strategy that manufacturers have adopted. In 1996, many washing machines had a capacity of 4.5-5kg. Now most of them are 6-7kg, even though the average number of people using that washing machine has declined. The machines are both more energy efficient and using more energy than they would have if they had stayed the same size.

The energy penalties of larger, but efficient, appliances are not great, but they are there. If the format of the EU Energy Label is the main reason they are being designed, manufactured and marketed as larger appliances, it would be beneficial to alter the label and remove the incentive. If the trend is then still towards larger appliances, it will clearly be because of consumer preferences. The expectation is that energy labels based on absolute consumption, not relative performance, would encourage downsizing. This is the policy behind the design of the energy label for cars in many countries, such as Denmark.

A similar theme is developing with housing, where the two dominant trends are occurring at different timescales: the turnover of the stock is slow, whereas new (smaller) household formation is relatively rapid. As a result, smaller households have to live in properties that were originally built for much larger families and the amount of space occupied per person is increasing. The energy penalties of additional space per person are not large if the home is energy efficient. In 1996, a super-efficient home cost £2/m² pa to heat, whereas the average was £6/m². However, in the least efficient homes, the cost was £15/m² – a very substantial penalty for extra space (DETR 2000).

Most developers (outside London) have been building properties for the archetypal family, despite its diminishing importance, without paying sufficient attention to the present and future household mix. With household size now below 2.4 people per household and falling, smaller properties and denser developments may be more appropriate. In 2002, there were already 7.4 million single-person households, 29% of the total. With an ageing population, this group is of growing importance, and many are living in large, underused properties (Houghton and Bown 2003). The poorest people spend more money per person on household energy because the lowest quintile consists predominantly of one or two person households (Fawcett 2003).

Finding: Separate, but interacting, policy initiatives are needed to enable people to move into more energy efficient homes and into smaller homes. These particularly apply to elderly, single pensioners living in under-occupied dwellings.

Finding: The replacement of policy on energy efficiency with policies on absolute energy demand may encourage downsizing and could inhibit, then reverse, the present trend towards larger equipment and more space per person. This would apply to policy on the energy labelling of buildings in the UK, under the Energy Performance of Buildings Directive and through the Home Information Pack.

9.10.3 Capital expenditure

The home of the future will have more capital equipment – this could be solar panels, micro combined heat and power, heat pumps – all of which will involve additional capital expenditure to the single boiler there at present. Consumers may obtain the same economic utility from each piece of equipment – it is used less frequently, so lasts longer – but there is a peak of capital expenditure when a new technology is adopted.

At the same time, the utilities will have to invest less in central plant, as there will be a lower level of demand for centralised electricity. This is because:

- the demand for electricity will be lower, as lights and appliances become more efficient;

- there will be less use of electricity for space and water heating – because of its carbon intensity, policy will have focused on reducing this through insulation and alternative energy sources;
- there will be more building-integrated generation, for instance through photovoltaics and micro- and community level CHP.

This situation requires a switch in capital outlay, from utility to householder. This could be achieved through a greater outlay by the individual householder or result from the development of energy service companies (ESCos), whereby the utilities invest in individual homes instead of centralised plant.

The net effect for society could be beneficial because the electricity transmission and distribution systems will only need to be upgraded and maintained to a lower capacity level. Significant replacement of the ageing electricity grid is needed in the near future and this, along with the decommissioning of coal and nuclear plant, gives the opportunity to plan strategically now.

One of the issues for policy is to recognise these different capital requirements and to support householder investment. Policy support is particularly important for low-income households that are renting or have no capital: 28% of all households have no savings and, by implication, no access to capital loans. Amongst the poorest households, those with a weekly income of less than £200, the proportion with no savings rises to nearly half (46%) (NCC 2004). The aim of policy has to be to ensure that the homes of the poorest people are disproportionately energy efficient so that they have affordable energy services, even at their low incomes.

Finding: Strong financial support will need to be focused on the owners of existing properties if they are going to improve their properties to the extent envisaged. These could include stamp duty rebates.

Finding: The policies envisaged in the 40% House scenario involve substantial capital flows, in non-traditional directions. Policy is needed to promote investment in energy efficiency and low and zero carbon technologies for all groups in society, both individually and collectively. One route of financing the LZC technologies in the home may be through energy service companies.

9.10.4 Equity

Equity is now a main driver of energy policy, through the provision of adequate and affordable warmth (and all other energy services in the home), and an important component of the approach taken in this project: climate change mitigation must not be achieved at the expense of the poor.

Recent policies to reduce fuel poverty have focused on raising incomes and lowering energy prices, and have had less effect on improving the energy efficiency of the properties they occupy. This makes the fuel poor vulnerable to energy price increases as a result of world energy trends. Additional upward pressure, particularly on electricity prices, will come from the increasing scale of the Energy Efficiency Commitment, the Renewables Obligation and other utility-based policies, if these result in higher costs being passed through to customers. In February 2004, before the recent price increases, the Fuel Poverty Advisory Group stated that Government expenditure on reducing fuel poverty needed to increase by 50% (FPAG 2004). This is now a considerable underestimate.

Existing policies are strongly criticised because they are having difficulty identifying and treating the worst homes. However, if they become better targeted, money will be spent on continuing the life of the worst properties. Although this is essential whilst occupied, there must be immediate intervention once one of these properties becomes vacant, so that no new occupant suffers. A complementary approach is to increase the quantity of new dwellings with low carbon footprints (from all uses of energy), probably also smaller in size (45-65m^2) specifically for the young or elderly in town centres. These would provide an acceptable choice for those fuel poor currently living in dreadful homes.

Finding: The 40% House scenario includes new, appropriate construction as a major contributor to reducing fuel poverty and releasing homes for demolition. The existing homes of the fuel poor need to be upgraded to a standard of SAP 80, as quickly as possible, to offset fuel price rises whilst ensuring that fuel poverty is eradicated.

9.11 Minimising costs

Policy can be used to reduce the cost implications substantially through an integrated, well-structured strategy such as market transformation (Boardman 2004b). Capital costs will be offset by considerable savings in running costs, particularly if fuel prices continue to rise. Hence, these details interact strongly with an assessment of the costs of the programme and of the constituent parts. The emphasis in the 40% House scenario has been on refurbishment rather than demolition, partly in recognition of the differing costs associated with these policies. The following are some of the components of the debate about ways to minimise costs:

- Early warning to industry about pending legislation and standards means they can plan and incorporate the necessary design changes into normal product development. This was achieved with the European minimum standard for fridges and freezers when a 15% improvement in the efficiency of models sold was achieved over a 15 month period, whilst the retail cost per appliance dropped 14% (Schiellerup 2002; Boardman 2004b). The aggregate saving to consumers was £285m pa, so there was a substantial net benefit to society.
- Expenditure on awareness-raising (eg through advertising) is necessary for an informed, supportive public and the cost accrues to Government or utilities.
- Incorporating more efficient lighting equipment into the home will require some necessary household expenditure, for instance the switch over to light emitting diodes over the next 25 years.
- Upgrading the quality of the existing housing fabric to the standard required will be costly. The expected increase in activity to eradicate fuel poverty and offset the effect of rising fuel prices will mean that some significant proportion of this expenditure stays the responsibility of central government, for instance in homes where the energy and money savings are insufficient to repay the capital.
- Incentives to richer households, for instance through stamp duty rebates, would involve government expenditure, but this could be offset by VAT receipts on the same investments.
- The introduction of LZC technologies to individual houses is expensive and the extent to which this is offset will depend upon the tariff paid to individual householders for the export or own-use of electricity. A feed-in tariff that covers the cost of the electricity generated would reduce some of these costs to nil. An alternative funding avenue is through energy service companies.
- Demolition potentially involves the largest expenditure. The costs depend upon the value of the property demolished: if it is already declared unhealthy or is sitting in a flood plain and uninsurable, then they will be lower. The sale of a development site will offset the costs in the former, but not the latter, case. If responsibility has been transferred to local authorities or regional housing boards, then central Government has to ensure they have sufficient funds.
- A lack of planning, or emergency responses, increase the costs considerably. An early commitment to a trajectory that gets the UK to the 60% target would minimise these costs,

whether they fall on the householder, the Government or other funders.

Finding: The capital investment associated with achieving the 40% House scenario will be considerably higher than present levels of expenditure on demand reduction in the residential sector, whether funded by Government, the utilities, or private individuals.

Finding: The cost implications of a 40% House scenario will be minimised by an early, clear, rigorous approach to planning, so that everyone, from the construction industry, to appliance manufacturers, to local authorities and householders, knows the direction of policy and can plan accordingly.

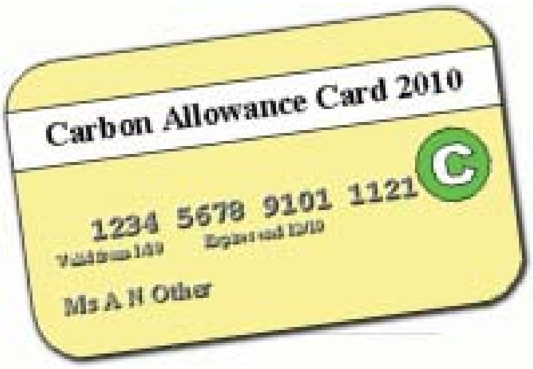
9.12 People transformation

Achievement of the 40% House scenario requires the active involvement and commitment of the public, particularly if gains in the efficiency of the housing stock are not to be lost through the purchase of additional electrical equipment. Whilst product policy can deliver a great deal, it is most effective when working with the grain of society. Therefore, policy should focus on developing an informed society that is supportive of strong climate change mitigation. This will not be easy, particularly as the dominant mindset appears to be in line with the World Markets scenario at present (Figure 2.2). The importance of public education (including practical initiatives) to develop understanding, support and everyday skills for low-impact ways of life cannot be stressed enough. This is needed at all levels and for all ages.

More specifically, the 40% scenario also implies a huge programme of training in the skills needed to design, construct and maintain a low-energy building stock, the appliances used within it and the technologies on which all will depend. The integrated approach to education and training for sustainable communities set out in the Egan review (ODPM 2004g) is one very much in keeping with the scenario, and one that needs implementing urgently.

Finding: An immediate training programme will ensure that the workforce has the skills to implement and maintain the 40% House scenario.

Finding: If UK society continues to develop along current trends, no carbon emissions reductions are expected by 2050.



Methods to encourage personal responsibility will be needed by 2050

A key element of the 40% House scenario is the development of a high level of carbon awareness, so that people want carbon reductions and are prepared to take personal responsibility. One way of achieving this would be through a system of personal carbon allowances (or tradable domestic quotas). This has a number of benefits, as it:

- is equitable – everyone has an equal allowance;
- will rapidly lead to an informed society, as people understand the carbon impact of their direct fuel purchases;
- ensures that carbon reductions can be guaranteed (by the amount of allowances issued);
- gives individuals the choice of where to make their carbon cuts, for instance offsetting emissions from travel with carbon reductions in the home.

Although not a major focus of this project, it is a fast developing concept – there has already been a Domestic Tradable Quotas (Carbon Emissions) Bill, introduced by Colin Challen, MP. Further work is being undertaken in this area through the UK

Energy Research Centre's Demand Reduction theme.

There is a strong link between policies on fuel poverty and personal responsibility: low-income households cannot be expected to take responsibility for their carbon impact when they have no capital or control over the energy efficiency of their home. Progress towards personal carbon allowances or residential carbon taxation depends upon minimising hardship for low-income households.

An alternative approach to triggering public action and involvement would be considerably higher energy prices. To achieve the 60% carbon reduction target, real prices would have to rise significantly. Household energy costs are already rising, with resultant increases in fuel poverty. The expectation is that UK governments would be reluctant to have a policy that relied on major additional increases in fuel prices, particularly those sufficient to confirm a 60% reduction in carbon emissions, as these are both unpopular and regressive.

Finding: Research is needed into the role that could be played by personal carbon allowances and to identify appropriate precursor policies that prepare and aid the public. The timescale for implementation needs to be considered, but a slow approach (longer than 10 years, say) jeopardises the 60% carbon reduction by 2050.

In preparation for greater carbon awareness, policies would be introduced to help make the public more aware of their carbon budgets – some are already in development. For instance, Ofgem is in discussion with utilities about the development of more informative bills that identify the actual amount of energy consumption over the last five quarters at the household level. Elsewhere in Europe this has proved to be an effective way of focusing people's minds and bringing forward energy-saving activity (Roberts et al 2004, Darby 2001). A separate initiative, required by the European Directive on electricity liberalisation, is the provision of information about the electricity fuel mix being purchased (the quantity that has come from coal, gas, nuclear or renewable generation) with or on utility bills (known as disclosure). The Department of Trade and Industry are requiring this information to be sent to customers from October 2005. Another way in which to encourage low-carbon responses from consumers is through a change in the tariff structure, so that unit costs increase with consumption. The reverse is the current situation.

Finding: The design of utility bills, electricity disclosure labels, tariff structure and the existence of the standing charge could all be considered in terms of discouraging consumption and improving the energy literacy of society. At the moment, they neither inform nor encourage careful consumption. This is a disservice to consumers at a time of rising energy prices and carbon concern.

9.13 Summary and conclusion: a 40% society

Society in 2050 under the 40% House scenario would contain these elements:

- there is considerable concern about climate change and a strong support for effective international action to reduce greenhouse gas emissions, particularly in the developed world;
- this concern is translated into comprehensive formal and informal training for low-carbon ways of life, from childhood through to professional and vocational training;
- a 60% reduction in carbon dioxide emissions in 2050 is seen as a minimal EU level of commitment that must be achieved;
- the UK has a national target of a higher reduction in greenhouse gas emissions;
- there is a high level of carbon literacy in society, so actions are focused and effective;
- there is a willingness by individuals to take action at home and elsewhere;

- companies are developing low carbon products: insulation, low-energy lights and appliances, and for generating electricity and providing heat in the home. The UK is at the forefront of these developments, supported by Government;
- proven low carbon technologies are adopted quickly by householders, creating and maintaining a market for these innovative industries;
- a strong community focus imbues decisions, reinforcing a regional housing policy and giving rise to denser town centres and the development of community-level energy networks;
- world fuel prices have risen substantially;
- equity is an important dimension, resulting in priority being given to policies that help the disadvantaged and elderly, along with a focus on healthy housing to provide the poorest with affordable warmth and other energy services;
- all of this has been achieved as a result of a clear energy and housing strategy that originated in 2005, despite the large number of Government departments and stakeholders involved.

The overarching conclusion of this project is that there is a desperate need for a clear strategy that brings housing and energy policy together, in the context of climate change commitments. The range of stakeholders, Government departments and present policy initiatives is not delivering the rate of change and focus required by the 60% target. The project has demonstrated that major reductions of carbon dioxide emissions could be achieved by 2050 in the residential sector, but only if tough decisions are taken soon in several policy arenas. These policies will contribute to all four of the Energy White Paper objectives: in addition to the climate change targets, the 40% House scenario reduces fuel poverty, increases security of supply and even improves competitiveness by creating a demand for low and zero carbon technologies that could well be developed in the UK.