UK CLIMATE CHANGE PROGRAMME AND DOMESTIC SECTOR END-USE EFFICIENCY

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ABSTRACT

Information in the UK Climate Change Programme suggests that carbon savings in the domestic sector from end-use efficiency improvements could amount to some 4.7MtC/yr in 2010, based on allowances for improvements to the building regulations, residential energy efficiency improvements and appliance standards and labelling.

This paper discusses detailed scenarios that have been developed using the BREHOMES model of the energy use of the housing stock to study the implications of this level of saving. These include a *Reference scenario*, in which current trends continue, and an *Efficiency scenario*, in which energy efficiency improvements happen as rapidly as seems feasible. The difference between them in 2010 is not much greater than 4.7MtC/yr, suggesting that this level of saving, whilst achievable, is ambitious. Nevertheless, cost-effectiveness calculations indicate that it would be economically justifiable when viewed as a national investment.

This leads to the question of how far present plans go towards achieving the savings. To address this, *Policy scenarios* have been developed taking account of the actions that are being put in place by the Government to increase the rate at which energy efficiency improves within the housing stock. The results indicate that additional or re-targeted policies may be required.

KEYWORDS

Domestic sector, energy efficiency, carbon savings, scenarios, cost-effectiveness, policies.

INTRODUCTION

Cutting global carbon emissions requires more sustainable development patterns. The UK's response is set out in the Climate Change Programme (2000) and the Third National Communication to the United Nations Framework Convention on Climate Change (2001). Although the UK Programme does not have specific sector targets, carbon savings in the domestic sector from end-use efficiency improvements could amount to some 4.7MtC/yr in 2010, based on allowances for improvements to the building regulations, residential energy efficiency improvements and appliance standards and labelling. These improvements are also important to address a key social aim of the Government - the elimination of fuel poverty.

This paper describes detailed scenarios that have been developed using the BREHOMES model of the energy use of the housing stock to study the implications of this level of saving. These include a *Reference scenario*, in which current trends continue, and an *Efficiency scenario*, in which energy efficiency improvements happen as rapidly as seems feasible, given rates of uptake observed historically. *Policy scenarios*, taking account of the actions that are being put in place by the Government to increase the rate at which energy efficiency improves within the housing stock, are also considered. The scenarios help to identify the savings that are likely to be achieved and whether more needs to be done to meet the 4.7MtC/yr saving in 2010, as well as targets that have subsequently been identified in the Cabinet Office Performance and Innovation Unit's Energy Review (2002).

REFERENCE AND EFFICIENCY SCENARIO METHODOLOGY

The BRE Housing Model for Energy Studies (BREHOMES) is a bottom-up model of the energy use of the housing stock. The model uses data on the ownership of energy-efficiency measures to establish the thermal characteristics of the stock. These data have been collected since the mid-1970s thus providing detailed trend information illustrating how the energy-efficiency of the stock is improving with time. The trends have been presented in a series of publications known as the Domestic Energy Fact File, the latest issue of which was published in 2001 (Utley et al (2001)).

The trends may also be used to assess the likely uptake of measures in the future, thereby permitting estimates to be made of the thermal characteristics of the housing stock in future years – and, hence, allowing calculations of future energy use using the BREHOMES model. The basis of the method is to fit s-curves to the ownership data. The market development for any product will generally be approximated by a s-curve. As an example, Figure 1 illustrates the s-curve fit to the available data for double glazing ownership, this curve indicating the most likely levels of future ownership based on past trends. Similar curves have been derived for wall insulation, roof insulation and draught proofing, from which the thermal characteristics of the stock in future years can be estimated. These characteristics form the basis of the *Reference scenario*.

Also shown on Figure 1 is another uptake curve. This is based on the fastest rate of acquisition that has been seen in the historical data for that measure being applied year-on-year until saturation is reached. Again, similar curves have been derived for the other measures, allowing the thermal characteristics of the stock in future years to be established for the *Efficiency scenario*. This scenario represents the fastest rate of improvement that could realistically be achieved without resorting to more radical measures (e.g. measures that are not currently usually found to be cost-effective).

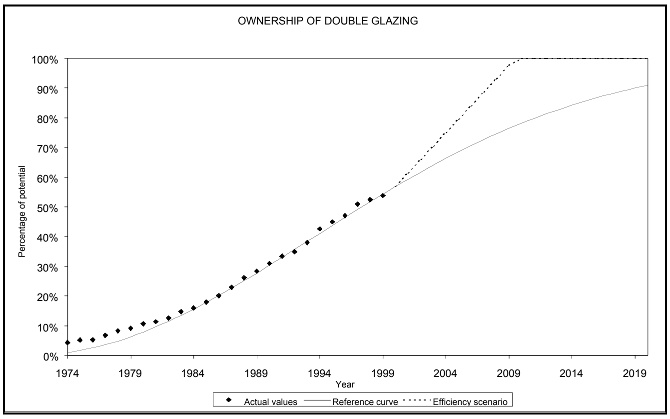

Figure 1: Ownership of double glazing: Reference and Efficiency scenario assumptions

The above description of the scenarios is a simplification. There are numerous other considerations that must be taken into account including, in particular, what is likely and what is possible for improvements to heating systems and to lights and appliances. Lack of space precludes discussion of these here. Full details are provided in Shorrock et al (2001).

REFERENCE AND EFFICIENCY SCENARIO RESULTS

Figure 2 illustrates the carbon emissions that correspond to the Reference and Efficiency scenarios. Two Policy scenario lines are also shown, the assumptions for which are discussed later. Note that the carbon emissions incorporate expected changes to emission factors for electricity, taking account of the changing mix of generation plant. By 2010, the emissions in the Reference scenario are 6% lower than the emissions in 2000. In the case of the Efficiency scenario the reduction is 20%.

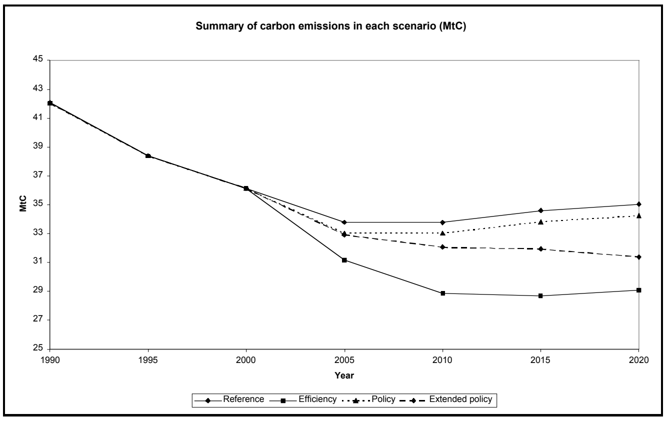

Figure 2: Scenarios for carbon emissions due to domestic sector energy use

The difference between the Reference and Efficiency scenarios in 2010 is 4.9MtC/yr, only slightly more than the previously noted 4.7MtC/yr figure from the Climate Change Programme. Thus, it is clear that the Climate Change Programme figure is ambitious, corresponding quite closely to achieving the Efficiency scenario. Since the mix of technologies applied in the Efficiency scenario is known it is possible to estimate the expenditure that is required to achieve it. The cost savings relative to the Reference scenario can similarly be calculated from the energy savings together with typical fuel prices.

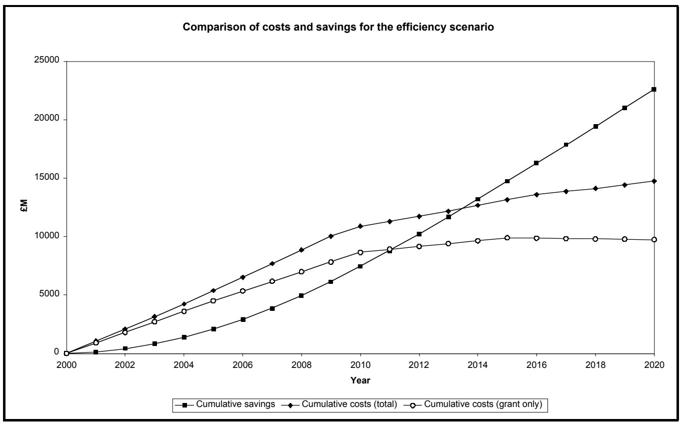

Figure 3: Costs and savings of the Efficiency scenario

As Figure 3 shows, the cumulative overall costs of the Efficiency scenario are initially greater than the cumulative savings but there is a reversal of this situation by 2014. By 2020 the cumulative costs amount to about £15 billion (€24 billion), but the cumulative savings are approximately £23 billion (€36 billion). This implies that the Efficiency scenario to 2020 is cost-effective for all discount rates below a certain threshold. Iterative calculation reveals that the Efficiency scenario is cost-effective at all discount rates below about 9.6% - a value that is greater than the rate of 6% to 8% that is normally assumed for cost-benefit assessments relating to the nation as a whole. This implies that the scenario would be very cost-effective for society as a whole. Furthermore, any savings beyond 2020, which would make the scenario even more cost-effective, have been ignored in this calculation.

ACHIEVING THE CLIMATE CHANGE PROGRAMME SAVINGS

Given that the Efficiency scenario looks attractive in cost-effectiveness terms, this raises the question of whether the plans that have been put in place by the Government will be sufficient to achieve such savings. Table 1 indicates the savings that need to be achieved if the Climate Change Programme figure of 4.7MtC in 2010 is to be achieved. Building regulations account for 1.0MtC/yr (significantly more stringent requirements were introduced in April 2002), appliance standards and labelling account for 0.3MtC, but the majority of the savings, 3.4MtC/yr, are assumed to come from energy efficiency improvements promoted through grants and similar mechanisms. The amount to which the latter figure is likely to be achieved can be checked using historical data on grants for energy-efficiency measures.

TABLE 1

Domestic sector end-use efficiency savings in 2010 from the UK Climate Change Programme

Building regulations	1.0MtC/yr
Appliance standards and labelling	0.3MtC/yr
Energy efficiency improvements through grants and similar mechanisms	3.4MtC/yr
Total	4.7MtC/yr

As an example of such data, Figure 4 illustrates how the acquisitions of cavity wall insulation have been affected in the past by the availability of grants. It is very clear from this that the acquisitions rise as the grant expenditure rises, although a closer inspection of the data reveals that there is a free-rider effect, which can be quantified (Shorrock et al 2001). Similar analyses have been undertaken for loft insulation (previously reported at EPIC '98 - Shorrock (1998)) and for condensing boilers, from which it is possible to make a good estimate of the savings achieved for each £M of expenditure on grants.

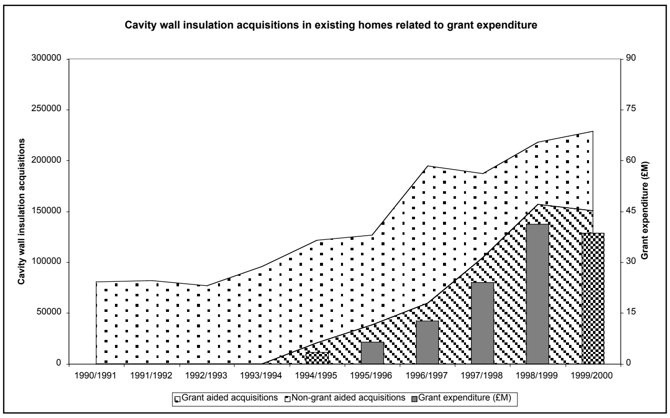

Figure 4: The effect of grants on the uptake of cavity wall insulation.

Figure 5 illustrates this. It shows that when grants were first introduced the saving achieved for each additional £M of expenditure was higher than now. This is readily understandable because the first grants were for the relatively inexpensive measure of first-time loft insulation, which achieves quite high savings. Now, the improvements being applied include more expensive measures. Loft insulation is still being applied but it is now largely topping-up of existing insulation, achieving lower savings. Nonetheless, the results indicate that current grants are achieving substantial savings. The slope of the line including the free-rider effect currently indicates a saving of 0.03 PJ for each £M of expenditure. Thus, given information on the planned expenditures on grants and similar funding mechanisms, savings relative to the Reference scenario can be determined.

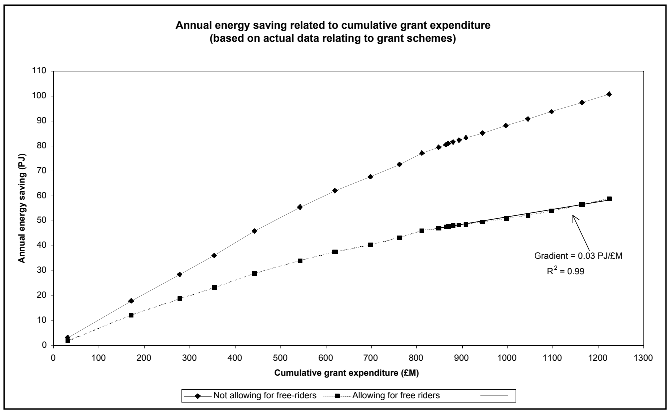

Figure 5: Annual energy saving related to cumulative grant expenditure

Planned "grant" expenditures up to about 2004/2005 are known and these are substantially higher than the levels that applied in the late 1990s. Beyond this, there are no specific figures available. However, it is reasonable to assume that funding will continue at a similar level, roughly £300M/yr, given the Government's commitments relating to Kyoto and other targets. Thus, estimated expenditures to 2020 can be determined and so savings relative to the Reference scenario can be deduced. Hence, Policy scenarios looking at the likely effect of grants can be constructed. These are shown on Figure 2. There are two Policy scenarios shown – the *"Policy scenario"* relates only to known expenditures to about 2004/2005 whilst the *"Extended policy scenario"* assumes that similar funding continues beyond this.

The results indicate that in 2010 the savings that are likely to result from grants amount to 1.7MtC/yr, which is about half of the figure that is required as indicated in Table 1. Hence, it may be concluded that planned grants and similar funding mechanisms fall short of what is required. Either the expenditure level needs to be increased or else the existing policies need to be re-targeted in such a way that they become more effective. In practice, a combination of re-targeting and increased expenditure will probably be required.

The need for such developments is emphasised by the recommendations of the recent Cabinet Office Performance and Innovation Unit Energy Review (2002). This recommends that *"in the domestic sector, the Government should target a 20% improvement in energy efficiency by 2010 and a further 20% in the following decade"*. Depending upon how such improvements are to be measured it could possibly be argued that the Efficiency scenario would meet the 2010 target, because it shows carbon emissions in this year 20% below those in 2000.

But, as Figure 2 shows, in the following decade there is no further reduction of carbon emissions in this scenario (although the thermal performance of the stock does continue to improve – hence, the point about how the efficiency improvement is to be measured). To achieve this will require much more radical improvements to be implemented, including measures that would not normally be considered currently cost-effective, as well as innovative new technologies (e.g. solid wall insulation, solar water heating, heat pumps, micro-CHP, photovoltaics).

CONCLUSIONS

Detailed scenarios for the energy use and carbon emissions of the UK housing stock have been developed. These indicate that the savings identified in the UK Climate Change Programme for the domestic sector should be cost-effective for the nation. However, the results suggest that present policies will need to be re-targeted and funding levels increased if the savings are to be achieved. Furthermore, targets identified in the recent Cabinet Office Performance and Innovation Unit Energy Review will require even greater improvements to be achieved, particularly in the period between 2010 and 2020.

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