ENERGY EFFICIENCY AND CONSUMPTION IN THE UK HOUSING STOCK

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INTRODUCTION

The pattern of domestic energy consumption in the UK has changed considerably since 1970. Successive revisions to the Building Regulations have greatly improved thermal insulation in new dwellings while the existing stock has also improved. There have been important changes in the fuels and appliances used for heating. Natural gas has rapidly penetrated the market to displace coal as the dominant fuel and there has been two-fold growth in the use of central heating over the period, over 70% of dwellings now being so heated.

BREHOMES

Much detailed information is needed to quantify all the changes that have taken place. Ideally, a specially designed survey would have been undertaken at regular intervals to gather detailed data at household level but this has only been done for small and unrepresentative samples. Nevertheless, several surveys are conducted in the UK which yield information related to energy use, including an extensive quarterly survey of home insulation measures and central heating systems undertaken by Audits of Great Britain. Reliable information is also available from the fuel supply industries on the total amounts of energy delivered to the domestic sector. BREHOMES (Building Research Establishment Housing Model for Energy Studies) uses data from various surveys to provide inputs to a physically based model of domestic energy use (Baldwin et al 1986). It enables a better understanding of the changes in consumption patterns in terms of both physical changes and trends in consumer behaviour.

TRENDS AFFECTING ENERGY EFFICIENCY

Thermal Insulation

Thermal insulation has been improved in many existing dwellings, most notably for roof insulation. Other significant contributions have come from cavity wall insulation and double glazing. The thermal insulation standards set by the Building Regulations were substantially improved in 1976 and 1982 and are currently under review (Department of the Environment 1985). The changes to date have reduced heat losses in the average new dwelling by about 30%. Although the number of new dwellings built per year represents only about 1% of the existing stock, it is calculated that the cumulative effect of the changes since 1976 has been to reduce average dwelling heat loss about 2.5%.

Using BREHOMES, it is possible to estimate the overall effect of improvements to thermal insulation. The heat loss of the average dwelling is calculated to have fallen by 15% between 1970 and 1986, a rate of about 1% per year.

Standards of Heating

Central heating is now installed in about 70% of the dwellings compared to only 35% in 1970 (source Audits of Great Britain). A temperature survey conducted in 1978 (Hunt et al, 1982)

showed that the average temperature in dwellings with central heating was about 2 °C higher than in those without. The switch to central heating has therefore had a large impact on heating standards. There is little evidence to show what has happened to dwellings without central heating but it is likely that they too are better heated, since surveys show that those dwellings have also had improvements to their thermal insulation. Field measurements show that the principal effect of improved insulation in partly heated dwellings is often on temperature rather than fuel use (Department of the Environment, 1984).

Efficiencies of Heating Systems

The efficiencies of new heating appliances have increased significantly since 1970 (McNair et al, 1984). This has had a direct effect through the replacement of appliances, amounting on average to several percentage points. A second and larger effect has occurred as a result of the switch to central heating where systems with a typical annual efficiency of 65% have replaced much less efficient individual fires. Replacement of gas boilers is now a major factor towards improved efficiency and may be expected to increase as more units reach the end of their useful life. Condensing gas boilers, with annual efficiencies of about 85% promise to make this the most important mechanism for improving energy efficiency in the housing stock in the coming decade (Trim, 1988).

Water Heating

Space and water heating systems are frequently combined in UK dwellings. Improvements to boiler efficiency have a similar beneficial effect for water as for space heating. Additionally, overall efficiency may be improved by insulating hot water storage cylinders. This form of insulation is now found in about 90% of cases and has made an important contribution to reducing energy use for water heating. Better control of systems and the greater use of fully pumped primary circuits have also had a beneficial effect.

Other uses of energy

Household lighting, cooking and electrical appliances account for about 20% of energy use in a typical UK dwelling. As much of this is electricity at on-peak tariff, its significance in terms of energy cost and primary energy is much greater. This category of energy use is subject to two trends which work in opposition with regard to their effect on energy consumption. Firstly, the number and range of domestic appliances is increasing at a substantial rate. Secondly, the efficiency of new equipment is often much better than old and consumption per unit is declining. The net effect since 1970 has been an increase of about 5% per year in energy use. However, large potential savings are possible through efficiency improvements. Low energy lighting is now widely available for domestic use, while new washing machines, refrigerators and freezers use significantly less energy than their predecessors. Microwave ovens should also help to reduce energy demand as they assume some of the functions of traditional cookers. On the other hand, dishwashers are major users of energy which have a low market penetration in the UK and may be a strong factor for growth in consumption over the next decade.

Overall energy consumption

Overall domestic energy consumption has remained fairly constant since 1970 but the proportions of the various fuels used have changed dramatically (see Figure 1). Natural gas has displaced coal as the dominant fuel, while electricity's share of the market is broadly unchanged and oil has declined from an already low starting point. These changes have resulted from natural gas coming on to the market at the beginning of the period and being available at a

price which declined in real terms throughout the 1970s. BREHOMES shows that improvements to energy efficiency have enabled improved standards of heating and greater use of household appliances without increasing average consumption.

QUANTIFIYING ENERGY EFFICIENCY IMPROVEMENTS

There is no generally agreed definition of energy efficiency in housing. Nevertheless, there is agreement about the factors that contribute to improved energy efficiency: better thermal insulation and more efficient, better controlled heating systems and domestic appliances. The common factor is that they serve to reduce energy consumption without reducing the level of service provided. It is thus reasonable to measure improvement in energy efficiency in terms of energy consumed for a given level of service. Figure 2 shows the effect of improved insulation in this way, using the 1970 standard of insulation as a reference and calculating consumption with actual heating standards. The gap between the actual and calculated consumptions may be attributed to the better insulation. By this criterion energy efficiency in the UK housing stock has improved due to better insulation by about 25% since 1970, calculated consumption being higher than actual by that margin. A similar analysis may be performed for other factors such as improved heating system efficiencies.

CONCLUSIONS

The UK housing stock is much more energy efficient than it was in 1970. It is better heated due to a doubling of the number of dwellings with central heating and thermal insulation and heating system efficiency has improved, both in new and existing dwellings. These improvements to energy efficiency have enabled the better heating standards to be achieved without increasing the energy consumption per dwelling. It is calculated that present day consumption would be about 25% higher than it actually is had insulation not been improved.

ACKNOWLEDGEMENTS

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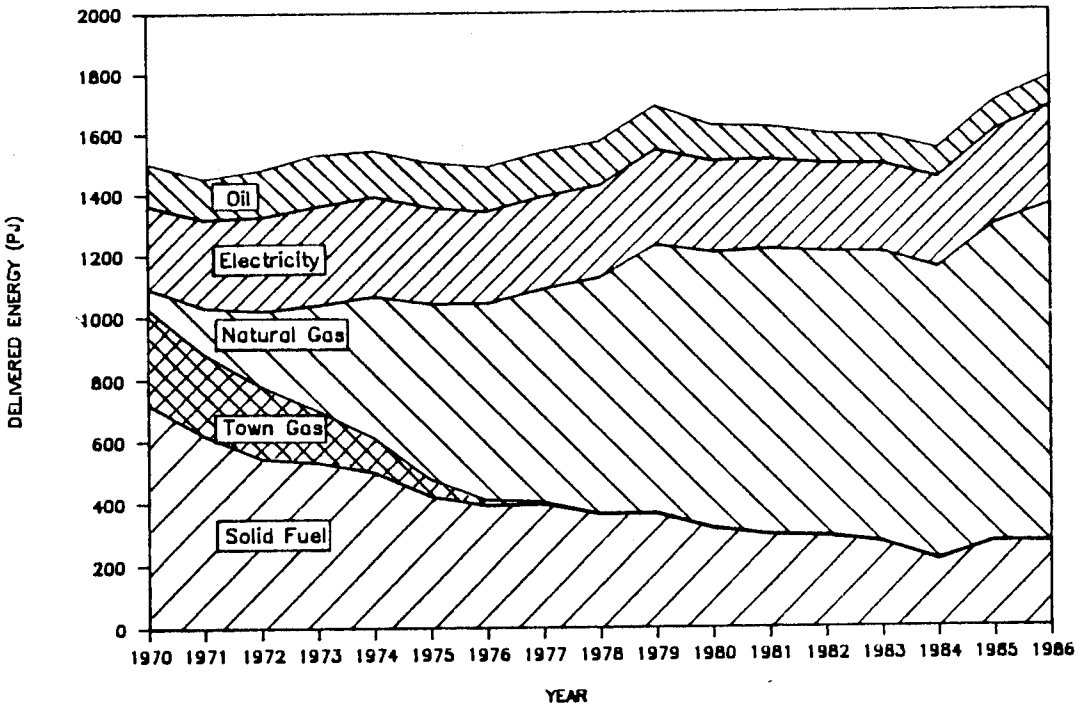

Figure 1. Housing stock fuel use. (Source Digest of UK Energy Statistics)

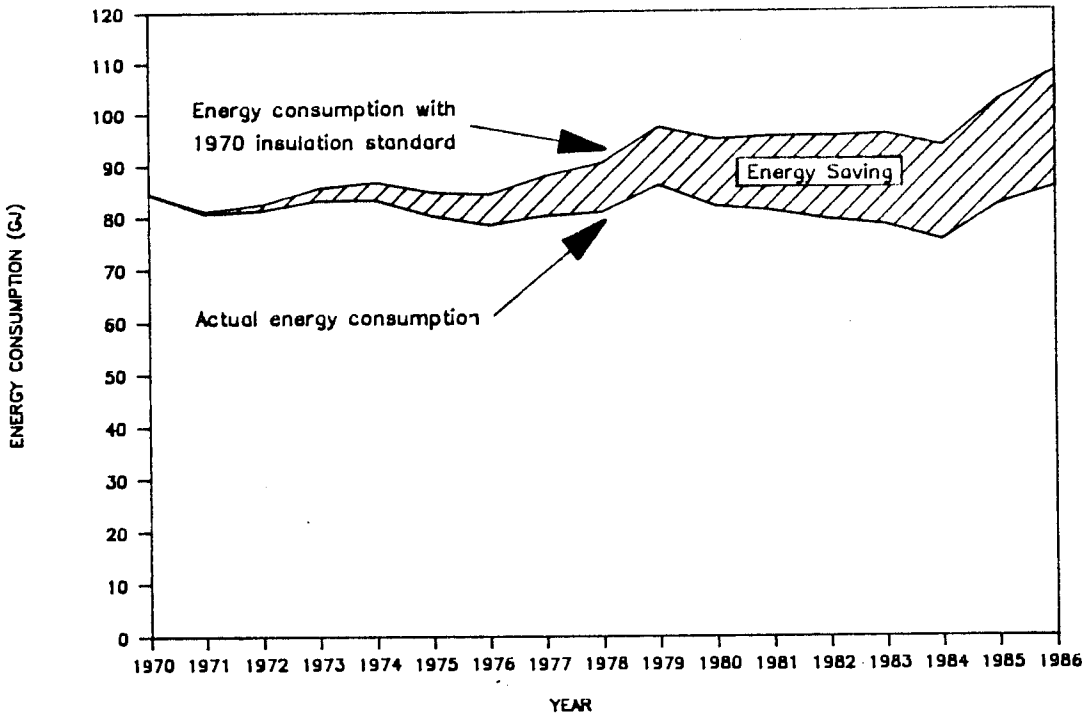

Figure 2. Energy consumption per household if insulation standard unchanged since 1970. (Source BREHOMES)