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Field studies on the effect of increased thermal insulation in some electrically heated houses

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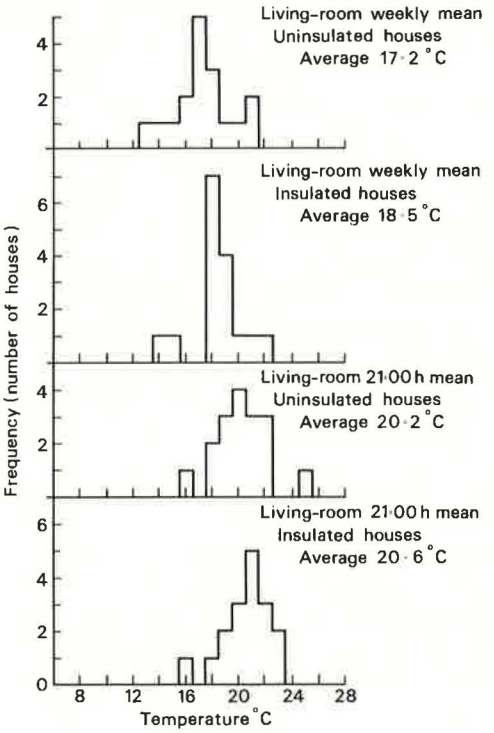
This paper summarises an article in *The Heating and Ventilating Engineer*, 1978, **52** (613) 6–12.

Measurements have been taken in a scheme of local authority two-storey terraced houses with a view to assessing the practical benefits of an improved standard of thermal insulation. The basic construction was external walls of brick–cavity–brick, single glazing, suspended timber ground floor, and tiled roof with 25 mm of mineral wool at ceiling level. Twenty houses were used as a control group – referred to as the uninsulated houses. In a further 18 – the insulated houses – the cavities were filled with urea-formaldehyde foam and the mineral wool thickness in the roof space was increased to 125 mm. The houses had partial central heating, consisting either of electric underfloor heating in the living-room and the hall or of a block storage heater in each of these two locations. Each house had an off-peak electricity supply for central heating and water heating, and a full-rate domestic supply for all other purposes.

Temperatures were recorded by thermographs, using a weekly chart. Most of the houses were monitored twice for one week between December 1974 and March 1975 and again for one week in February/March 1976. Histograms of the week's mean temperature in the living-room, bedroom and whole house are shown in Figure 1, together with the 21.00 h temperatures in the living-room (actually the mean



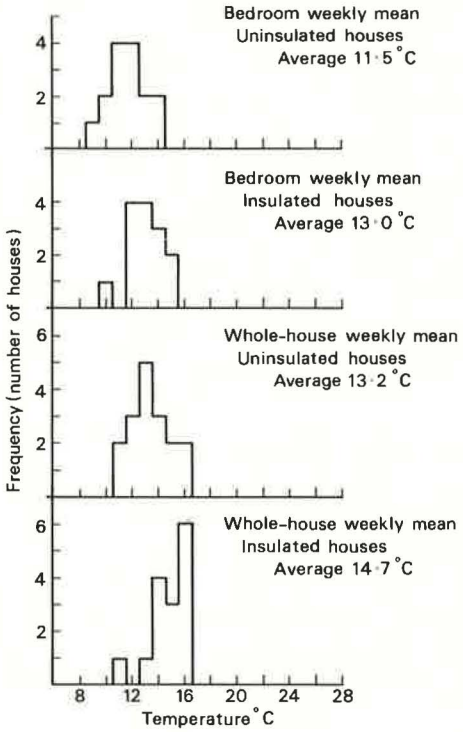


Figure 1 (a) Distributions of weekly and 21.00 h mean temperatures for living-room: from recordings made in December 1974 and January 1975

(b) Distributions of weekly mean temperatures for bedroom and whole house: from recordings made in December 1974 and January 1975

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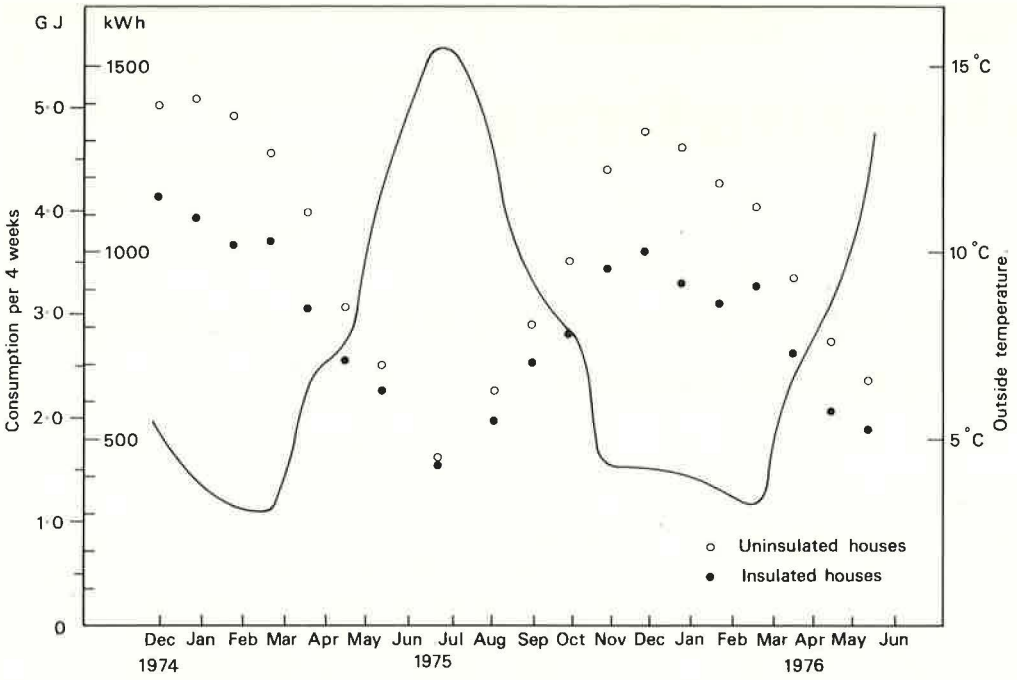

Figure 2 Mean electricity consumptions (domestic and off-peak) for each 4-week period (left-hand scale). The solid line shows the variation in the mean outside temperature (right-hand scale)

temperature between 20.00 h and 22.00 h averaged over the 7 days). In general there was little variation in temperature throughout a given house except for the living-room and kitchen. In the insulated houses, whole-house temperatures were generally 1.0 – 1.5°C higher than those in the uninsulated group, although there was a considerable range of this temperature between houses within each group. Taking the mean value for each group, the difference between house average temperature and outside temperature was 14 per cent higher in the insulated houses. For the visit during February 1976 the same general patterns were found again except that the temperatures were 1°C or so lower than in the previous winter (although the outside temperatures were similar). Both groups were affected almost to the same extent, the average inside to outside temperature difference again being 14 per cent higher in the insulated houses; and there was a corresponding reduction in fuel consumption of about 10 per cent in both groups in the second winter compared with the first winter.

The higher temperatures in the insulated houses show that the maximum benefit in terms of fuel saving was not obtained. However the living-room evening temperatures were very similar in both groups of houses. This would suggest that the occupants endeavour to obtain a certain 'target' temperature in the living-room in the evening, so that the higher weekly mean temperatures may be the result not of the wishes of the occupants but of factors beyond their control; for example, cavity wall insulation increases the thermal time constant of the structure giving a slower rate of cooling during the night, and the increased insulation in the roof space is liable to cause an increase in the temperature in the upper storey even if the temperature downstairs remains the same.

The average fuel consumptions for each group of houses are shown in Figure 2 for 4-weekly intervals between December 1974 and June 1976. The variation in outside temperature is also shown in the figure. During the winter months the fuel consumption in the insulated group was about 22 per cent less than that in the uninsulated group. This fuel saving accounts for about three-fifths of the potential benefit from the improved standard of insulation, the remainder being accounted for by the higher temperatures recorded in the better insulated houses. Annual figures for the reduction in fuel consumption are rather less, in the region of 18 per cent, as there is a minimum requirement for water heating, cooking, etc, which continues through the summer and which is unaffected by the insulation.

An additional electricity meter was installed in the houses included in this survey which measured only the electricity consumed by the water heater. This consumption was found to depend on household size, but there was no systematic difference in the consumption between houses in the insulated and uninsulated groups, and the mean consumption for each group was 900–1100 MJ per 4 weeks.

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