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July 1990

BEST PRACTICE PROGRAMME

Future Practice R&D 1

ENERGY EFFICIENCY IN NEW HOUSING

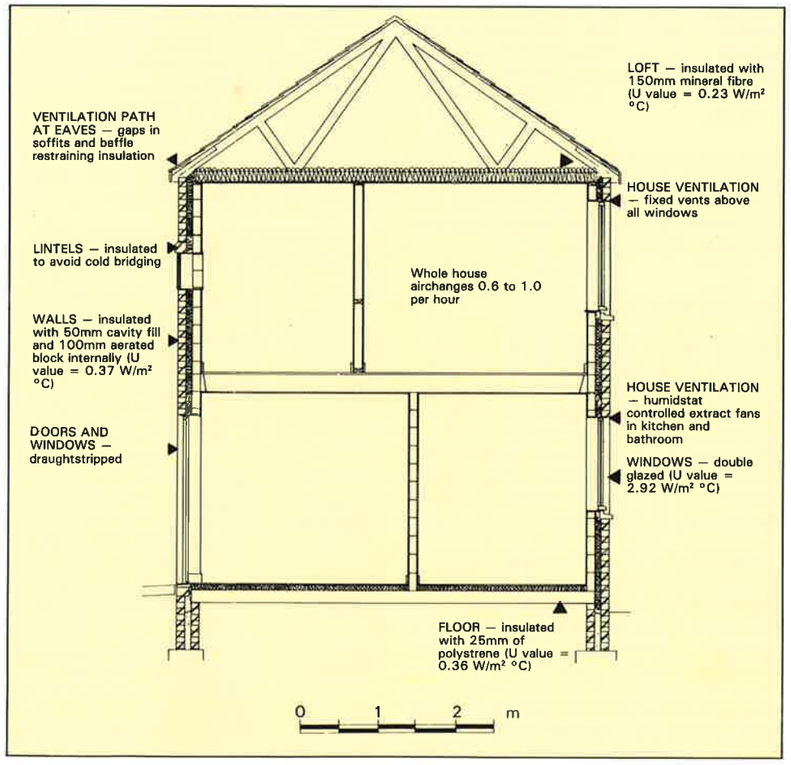
LOW-ENERGY HOUSING AT LITTLE OR NO ADDITIONAL COST

The Study and its Aims

The benefits to the householder of low energy design have long been appreciated. However, recent work has indicated that energy efficient designs may provide such benefits at little or no extra cost, clearly an important additional benefit to the housebuilder. BRE's Energy Conservation Support Unit (BRECSU), on behalf of the Energy Efficiency Office, commissioned a study, undertaken in 1988, to investigate this claim and to determine optimum combinations of energy-related measures for a range of different dwelling types. This is a summary of that work.

The study developed and evaluated optimum design solutions starting from six actual house designs chosen from current private sector new build practice.

Each design solution incorporates higher levels of insulation (and thus enjoys lower fuel bills) than its 'conventional' equivalent, but costs little or no more to build.



Energy Efficiency Office
DEPARTMENT OF ENERGY

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LOW ENERGY HOUSING

Table 1: Summary of likely cost and energy savings for optimum designs

	2 bed Flat	2 bed Terraced	3 bed Semi-detached	3 bed Bungalow	3/4 bed Detached	4 bed Detached (Large)
Gross Floor Area	49 sq.m	56 sq.m	80 sq.m	82 sq.m	114 sq.m	140 sq.m
Annual space heating savings						
Compared to '85 Regs — up to:	51% (£40)	57% (£56)	49% (£91)	39% (£96)	43% (£123)	43% (£155)
Compared to '90 Regs — up to:	47% (£34)	51% (£46)	44% (£75)	30% (£63)	36% (£94)	37% (£119)
Likely construction cost savings						
Compared to '85 Regs — up to:	£110	£180	£350	£590 (extra)	£420 (extra)	£310 (extra)
Compared to '90 Regs — up to:	£100	£340	£540	£140 (extra)	£120 (extra)	£40
Appropriate Heating Systems	'Homewarm' Electric off peak	Gas room heaters 'Homewarm' Electric off peak	Gas room heaters Conventional 'wet' Electric off peak	Conventional 'wet' Electric off peak	Conventional 'wet' Electric off peak	Conventional 'wet'

Note: In this comparison, '85 Regs and '90 Regs designs are assumed to have conventional wet central heating systems, of the same size. Space heating savings are for gas systems.

Cost and Energy Savings Compared

The study compared the costs and predicted fuel savings of the 'optimum' designs with designs to 1985 Building Regulations thermal requirements, and with designs to 1990 Building Regulations requirements. Table 1 summarises the results.

'Optimum' design solutions for the smaller dwellings (up to the 3-bed semi) produce energy savings of up to 50% of space heating costs — and need cost no more to build than those which comply with 1990 Building Regulations standards. Similar percentage energy savings are possible for larger houses with only minor increases in overall construction costs; around 1%. If these are passed on to the user, the simple payback period for the predicted savings in these larger dwellings is at most some 3-4 years.

Technical Assumptions and Buildability

Environmental conditions assumed for analysis of the 'optimum' design solutions were as follows:

- Internal design temperatures of 21°C for living rooms, 18°C for bedrooms.
- External design temperature of −5°C
- Central England location (2500 degree days per year)
- Ventilation rates of between 0.6 and 1.0 air changes per hour.

Heating was assumed to be in two periods per day giving a total of 9 hours heating. Generally, increasing, the internal design temperature up to 23°C or the ventilation rate to between 1 and 1.5 air changes per hour, could be accommodated without altering either heating system or fabric insulation level.

The proposed water heating systems could cope with higher than average levels of domestic hot water use.

As long as trickle vents and extract fans are provided as appropriate, the 'optimum' design solutions do not increase the risk of condensation over conventional designs. In fact, warmer, well insulated, double glazed dwellings with insulation distributed evenly around all elements are known to perform better in terms of condensation that their 'conventional' counterparts.

The use of the technically sound, simple measures is critical. Individual elements within the proposed design solutions are neither special nor innovatory and there is an established body of technical guidance on all the suggested measures.

Careful site supervision is required to ensure that insulation is properly installed. This also contributes to a better quality house overall, and this improved quality is increasingly associated with energy efficient housing.

Marketing Advantage

Although savings on fuel bills are an obvious attraction, energy efficient design solutions offer other environmental advantages. Low energy dwellings help reduce, national consumption of fossil fuel with related environmental benefits, as well as providing people with more comfortable, warmer, draught-free homes. These design solutions can be achieved discreetly, without compromising traditional styles.

Furthermore, the proposed designs exceed the thermal requirements in the 1990 Building Regulations at little or no additional construction cost. These energy efficient homes will make a significant contribution to reducing the Greenhouse Effect.

So, there is a three fold advantage here: a low cost route to compliance with the 1990 mandatory requirements; an opportunity to improve comfort and reduce fuel bills for the buyers of new houses; and a valuable contribution to an improved environment.

The following house types were evaluated:

- Two-bedroom flats/maisonettes
- Two-bedroom terrace houses
- Three-bedroom semi-detached houses
- Three-bedroom detached bungalows
- Three/four-bedroom detached houses
- Large four-bedroom detached houses

Figure 1 shows estimated capital cost and fuel bill savings for each of the six optimum designs. Construction costs were estimated by Chartered Quantity Surveyors, Davis Langdon and Everest, using standard estimating techniques. Energy performance was predicted by the ECD Partnership using the BRE Domestic Energy Model, BREDEM.

Optimum Combinations

The aim was to identify the combination of energy related measures which most effectively reduced energy consumption at no additional cost. In all cases this involved a new balance of 'buildable' insulation measures with appropriately designed space and water heating systems. In short, well insulated houses need smaller, simpler heating systems and money saved on these systems covers the cost of additional insulation. The resulting design solutions cost little or no more to build than their conventional counterparts, but are considerably more energy efficient.

In detail, a range of fabric insulation measures was evaluated in terms of energy effectiveness, construction costs, buildability and possible technical risk. A variety of available gas and electric heating systems were also investigated in order to identify suitable options for each of the six house designs.

Table 2: Insulation measures for optimum designs

External Walls	100mm facing brick, 50mm wide cavity fully filled with expanded polystyrene or mineral fibre insulation. 100mm aerated block and 13mm lightweight plaster. ($U = 0.37$ W/m² °C) *or* 100mm facing brick, 75mm wide cavity fully filled with expanded polystyrene or mineral fibre insulation, 100mm dense concrete block and 13mm lightweight plaster. ($U = 0.36$ W/m² °C)
Ground Floors	25mm expanded polystyrene insulation placed above or below solid floor slab. ($U = 0.36$ W/m² °C)
Roofs	150mm mineral fibre insulation laid between joists. ($U = 0.23$ W/m² °C)
Windows	Double glazed; sealed unit comprising 2 x 4mm glass, 6mm air gap in standard frames. ($U = 2.92$ W/m² °C)
Doors and Windows	Draughtstripped

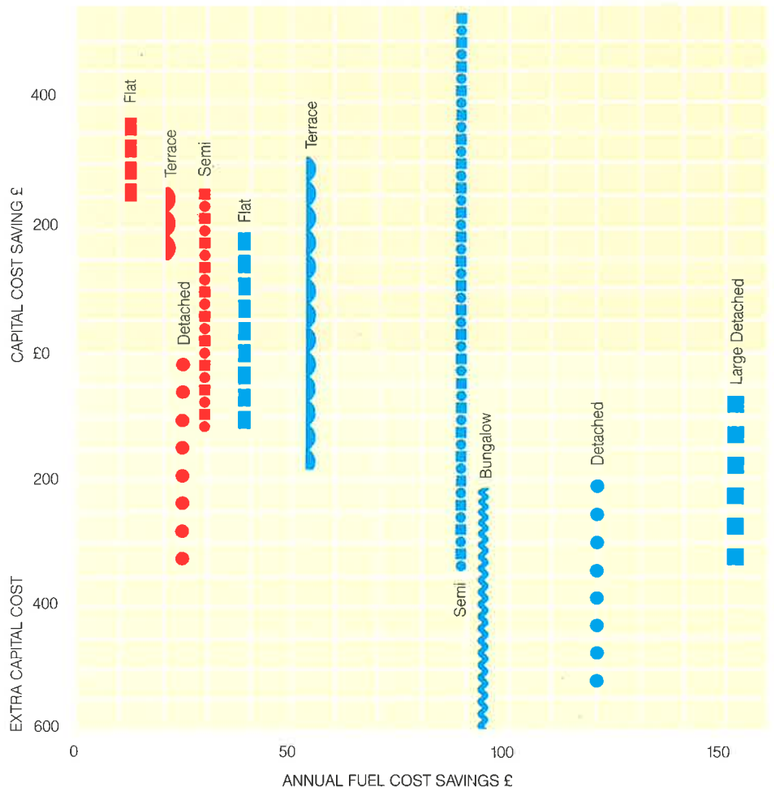

Figure 1: Optimum designs compared to 1985 Building Regs equivalents — Range of construction cost differences.

Table 3: Heating systems for optimum designs

Heating System	Suitability	Features/ Characteristics
Conventional 'wet' central heating	All dwelling types	Boiler and radiators appropriately sized for low heat loads. Economical layout of radiators possible with high insulation levels and double glazing.
'Homewarm'	Small dwellings (up to 2 bed-terrace)	Small boiler for space heating and hot water. Primatic cylinder eliminates need for F & E tank.
Gas room heaters	Small dwellings (up to 3 bed-semi)	2 room heaters (living room and hall) heat whole house; combined gas fire and circulator for space heating and hot water.
Electric storage heaters	All dwellings	Off-peak storage heaters with small amount of on-peak back up. Economy 7 water heating.

The identified optimum fabric insulation levels are not excessive. All measures were selected within stringent technical, practical and financial constraints. Indeed the individual measures are already commonly found in new house designs. Table 2 presents details of these measures.

Chosen heating systems range from small and simple space heating and hot water systems in smaller dwellings to more conventional gas fired 'wet' systems for larger dwellings. Table 3 briefly describes these systems.

In accordance with good building practice, all designs include trickle ventilators and extract fans in kitchens and bathrooms to minimise condensation.