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PASSIVE SOLAR DESIGN

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A development at Giffard Park in Milton Keynes has made use of passive solar design, amongst other measures, to cut fuel bills. The results of a period of monitoring show the extent of these savings.

The development at Giffard Park is in four terraces.

A scheme built at Milton Keynes' Giffard Park has demonstrated that passive solar design can bring space heating costs for four person homes down to less than £1 a week.

The project is being monitored to show energy consumption and results show savings through the use of passive solar design features. These features include careful site planning and orientation to allow maximum solar gain. All main living rooms in the development are on the southern side with 75 per cent of the glazing on the south elevation. Other solar features include direct solar gain, insulating blinds and gravity fed hot water systems.

The project has 36 dwellings for single people and childless couples on a one acre site in Milton Keynes. All the dwellings, which include 1, 2 and 4 person units are for rent. The passive solar design features are part of a package of measures which include improved standards of thermal insulation and individual room heaters as opposed to conventional central heating. The 36 dwellings are arranged in four terraces. All of them face due south and all habitable rooms are positioned so as to take advantage of solar gain.

Insulation measures include 25mm under the ground floor slab, 75mm batts in the external wall cavity and 140mm fibreglass in the roof space. The houses were completed and occupied in August 1984 and monitoring was carried out from September 1983 through to February 1986. Results of the study show that the space heating load has been reduced by 61% compared to similar dwellings built to 1982 Building Regulations Standard.

The scheme was designed by the ECD Partnership who applied for an energy efficiency demonstration grant in order to learn as much as possible from the ▶

◀ monitoring programme.

Passive solar design

In order to make the most of free solar heat gains, ECD decided to orientate the terraces to face due south and space them apart sufficiently to minimise overshading effects in winter. The distance between terraces is about 17 metres, the maximum that could be achieved on the site. David Turrent of the ECD Partnership explains:

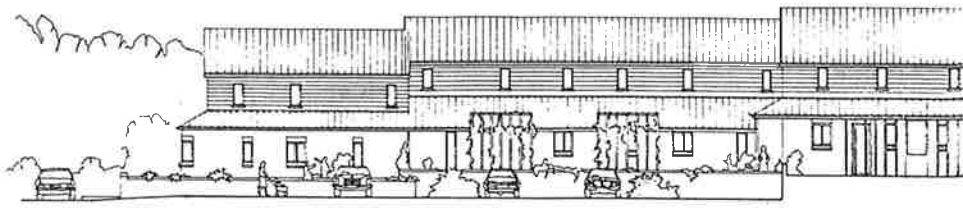
"Previous research has shown that double glazed windows with a southern orientation collect more energy than they lose for most of the year, except in December and January. Most of the benefit is felt in September/October and March/April, the effect being to reduce the length of the heating season. Our design strategy was therefore to increase the area of south facing glazing whilst reducing that on the north elevation to minimise heat losses. At the same time the flats were planned internally so that all habitable rooms face south and the north side is used for staircases, kitchens, bathrooms and storage."

Thermal insulation standards were improved but costs had to be controlled very tightly. 140mm fibreglass in the roof, 75mm batts in the external wall and 25mm polystyrene below the ground floor slab were the main features. Double glazing was specified and all windows and doors were draught-proofed. For space and water heating, ECD decided against conventional heating and opted instead for individual room heaters and water heaters. This gave each tenant direct control and, in theory, minimised wasteful use of energy. The system was less expensive to install and the cost savings were used to partly offset the extra costs of thermal insulation materials. Each bedroom or bed sitting room is fitted with a balanced flue gas convector heater and gas fires are installed in living rooms. Water heating is provided by instantaneous heaters or, in the four person houses, gas circulators connected to storage tanks.

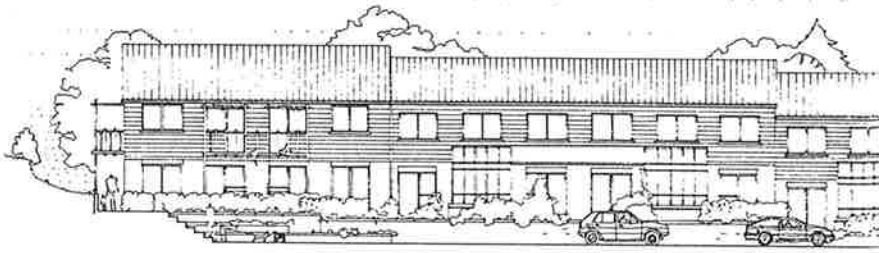
"The benefits of passive solar design are enhanced if effective night time insulation can be added to the south facing windows. One method is to use insulated roller blinds with edge sealing to minimise convective heat loss. One product was under development at the time so this was specified in one terrace. A solar water heater, also under development, was fitted in the four person houses to complete the demonstration aspect of the scheme."

Monitoring

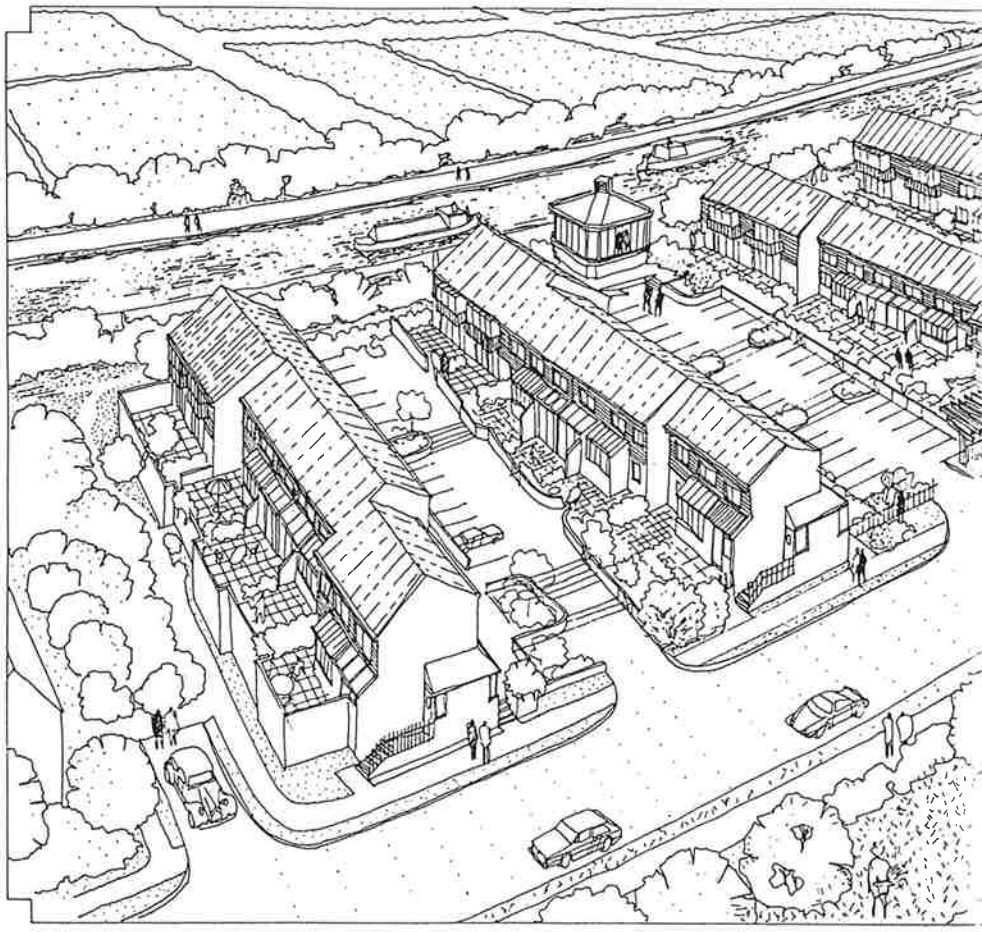
The monitoring process was divided into three stages: a study of the construction process (buildability); measurement of fuel

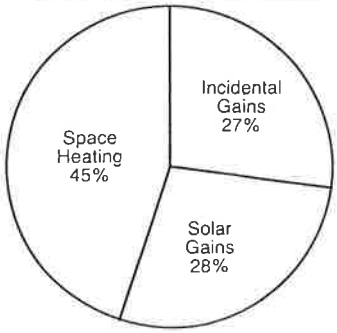


NORTH ELEVATION



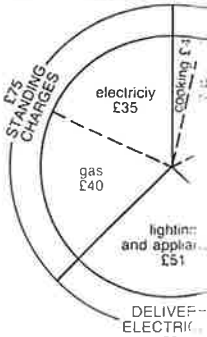
SOUTH ELEVATION





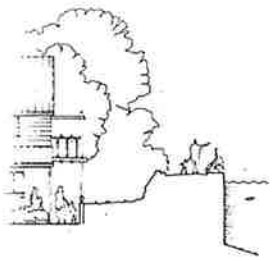
Terrace as built

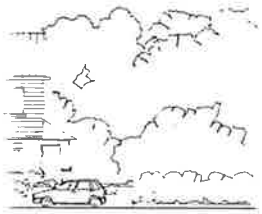
Incidental gains	52.3 GJ
Solar gains	54.0 GJ
Space heating	84.8 GJ
	191.1 GJ

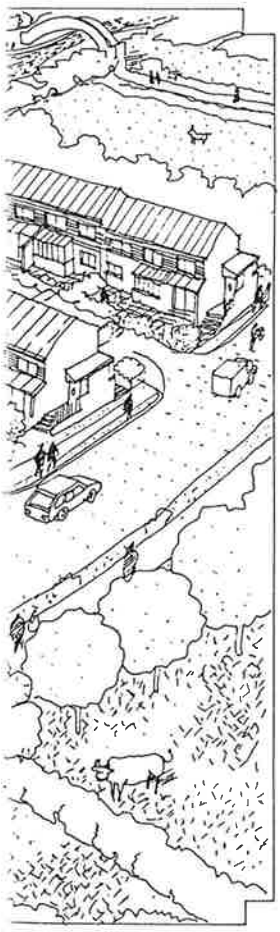


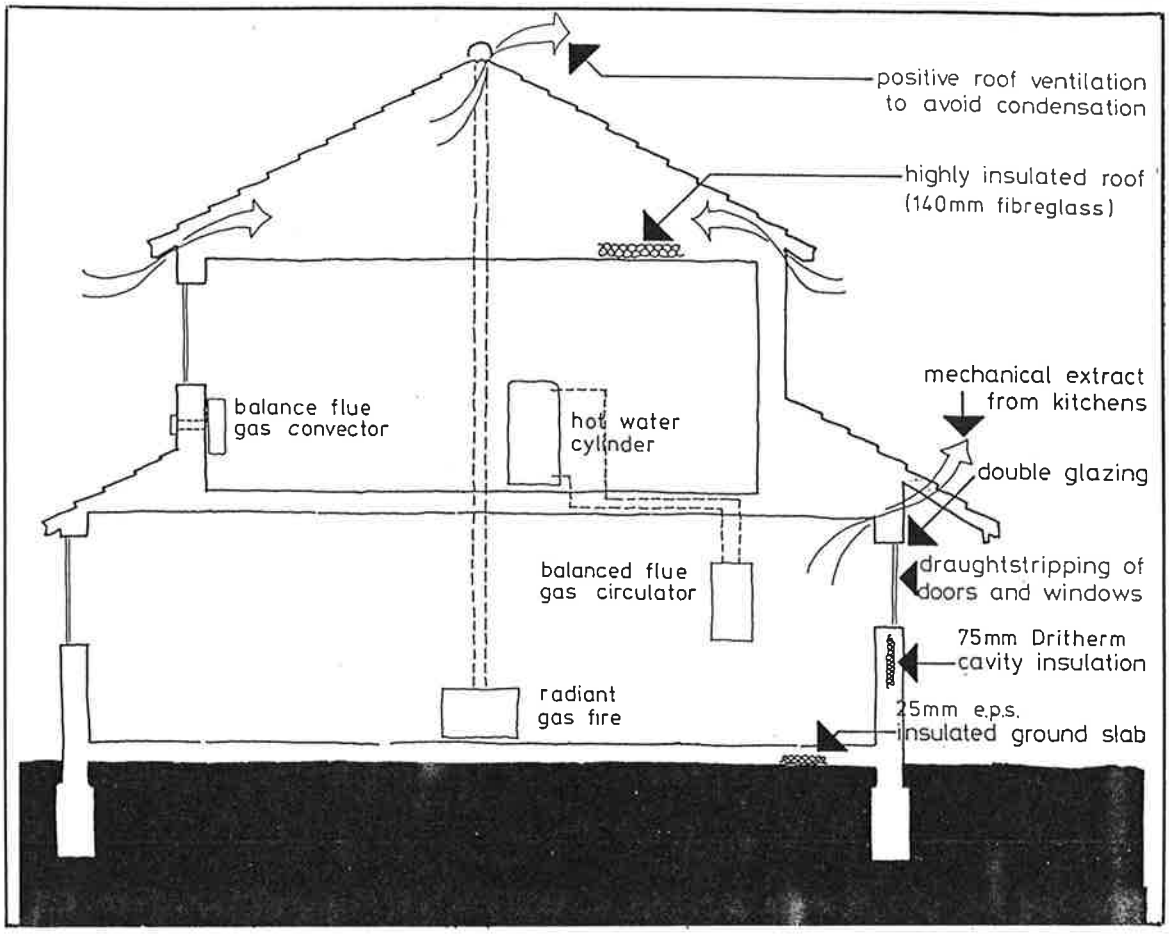
BREAKDOWN OF USEFUL HEAT INPUTS — TERRACE D

BREAKDOWN

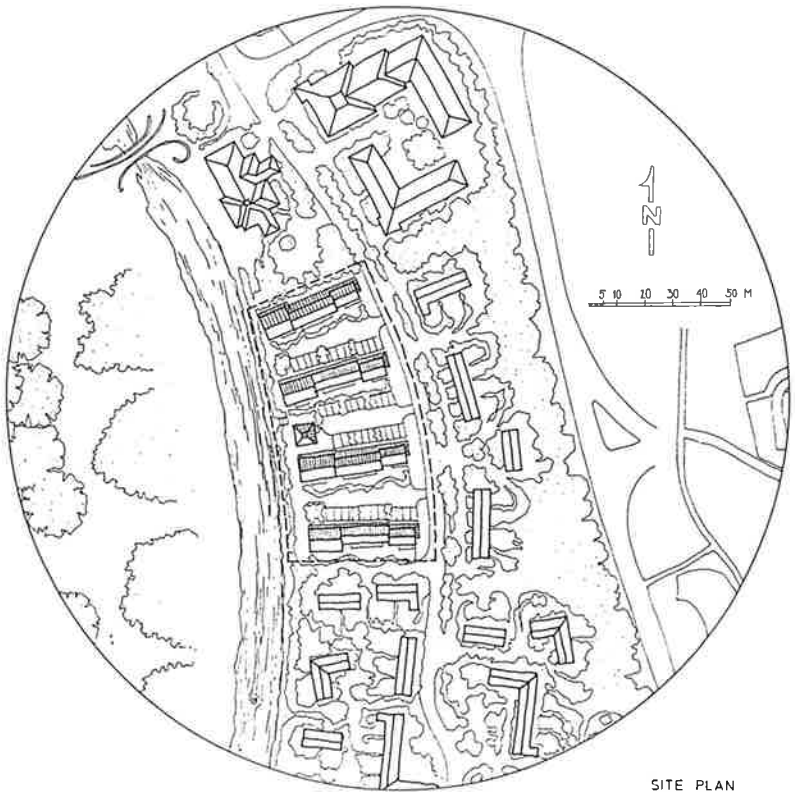








Left: These drawings show the orientation of the site. The terraces face south and all habitable rooms are positioned to take advantage of solar gain. Above the energy saving measures employed are outlined.



SITE PLAN

Above: the site plan shows the position of the development in relation to the surrounding area.

2 Person Units

Total fuel cost = £123
(excl. standing charges)

Left: These diagrams show a breakdown of useful heat inputs and a breakdown of annual fuel costs for the 2 person units.

ANNUAL FUEL COSTS

◀ consumption and temperatures after occupation; and a survey of occupants reactions.

As far as buildability was concerned there appeared to be no significant problems.

Average annual fuel bills were low: approximately £300 for four person houses and under £200 for two people and one person flats. Weekly fuel costs were estimated as £1.50 - £2.50 per person for the four person units; £2.00 - £2.50 for the two person flats and £3.70 for the one person flats. In all the dwellings space heating costs were low — about 61p per week per dwelling averaged over the year. Results show that space heating costs were comparable with those for hot water, much less than those for lights and appliances, and formed less than 20% of the total fuel bill.

As far as thermal performance is concerned, the total heat loss coefficient for a terrace of 9 dwellings has been reduced by 38% compared to the likely figure had the design conformed to the minimum requirements of the 1982 Building Regulations only. "As a result", said David Turrent "the net space heating requirement has been reduced by 61%.

"Incidental gains provided 31% of the gross heating requirement of a terrace, solar gains provided 25% and the auxiliary heating system provided 44%."

Cost effectiveness

The annual saving in delivered gas (averaged per dwelling) was 5222kWh (18.8 GJ) which was worth £58.4 at 1984 prices. This excludes the contribution of the solar water heaters which was about 12% of the hot water requirement.

The net cost of the package of measures (excluding solar water heaters and insulating blinds) was £17,895 in total (£497 per dwelling). Payback time is estimated at 8½ years. This, say ECD, is considered cost effective for this type of housing. The solar water heaters did not, however, prove to be cost effective, with a payback time greatly exceeding the expected lifetime of the system. In David Turrent's opinion, significant improvements in system performance and large cost reductions would be required in order for the system to approach cost effectiveness.

"The general house design, particularly the passive solar features, proved very popular with the occupants," added Mr Turrent.

Lessons

Lessons were learned during the monitoring of the project. The problem of condensation, common to many other 'first generation' energy saving schemes, manifested itself mainly in the bathrooms. The problem was largely alleviated, however, by the installation of humidistat controlled extract fans in all bathrooms. The project has underlined the need for a whole house ventilation strategy as an integral part of the energy saving package. Monitoring showed that room heaters provide a cheap and effective source of space heating. They are however constrained by available wall space and impose limitations in areas like kitchens and bathrooms.

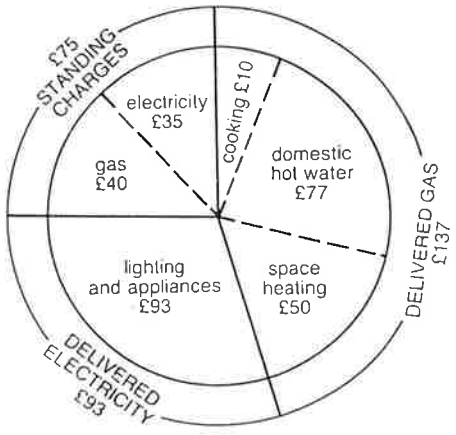
The following insulation measures were found to be cost effective:

140mm roof insulation	U=0.25 W/m²k
100mm wall insulation	U=0.30 W/m²k
50mm floor insulation	U=0.47 W/m²k

"We now specify sealed unit double glazing as standard, together with high performance timber windows," added David Turrent, "All windows are also specified with trickle ventilation."

More details of the project and the monitoring report can be obtained through the ECD Partnership. For more information use the reader enquiry number given below.

CIRCLE 166



4 Person Units

Total fuel cost = £230 (excl. standing charges)

BREAKDOWN OF ANNUAL FUEL COSTS

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