May 1992

10730

BEST PRACTICE PROGRAMME

Good Practice Case Study 90

ENERGY EFFICIENCY IN NEW HOUSING

INCORPORATING PASSIVE SOLAR DESIGN

Lawrie Park Road - Passive Solar Design as part of an integrated approach to low energy homes

Background

Colvin Close, Lawrie Park Road is a newbuild development of eighteen 3 bedroom family homes completed in 1983. They were commissioned by Lewisham Borough Council and designed by Lewisham's architects department with the South London Consortium (SLC) as energy advisers.

Lewisham were concerned that in a climate of rising fuel costs tenants were finding it increasingly difficult to heat their homes, even with efficient new heating installations. The energy brief for the new homes at Lawrie Park Road was to meet the need for affordable warmth without significantly overreaching Lewisham's capital cost constraints, or compromising architectural standards and comfort conditions.

The houses were designed and built according to the principles of an integrated approach - as defined by SLC Energy Group's 'four rules':

- Attention should be paid to solar gain, heat recovery etc in the context of the scheme.
- Insulation applied evenly to the whole building envelope achieves more than the same volume of insulation applied to only one element.
- Draught reduction is a major factor in energy saving.
- Comfort is improved by balancing ambient (air) and radiant (surface) temperatures.

THE ENERGY EFFICIENCY PACKAGE

- 13.5m^2 (71%) of each house's total glazed area faces south, only 5.5m^2 (29%) faces north.
- Circulation and service rooms are located on the north of the houses, bedrooms and living areas on the south.
- Extensive living room glazing to form sunspaces.
- 200mm roof insulation, 19mm insulation to ground slab, cavity fill and drylining to walls.
- Double glazing and draughtstripping throughout.
- Warm air heating/ventilation system redistributes incidental heat gains throughout the house.
- Highly insulated hot water cylinders.

The design also included an experimental measure:

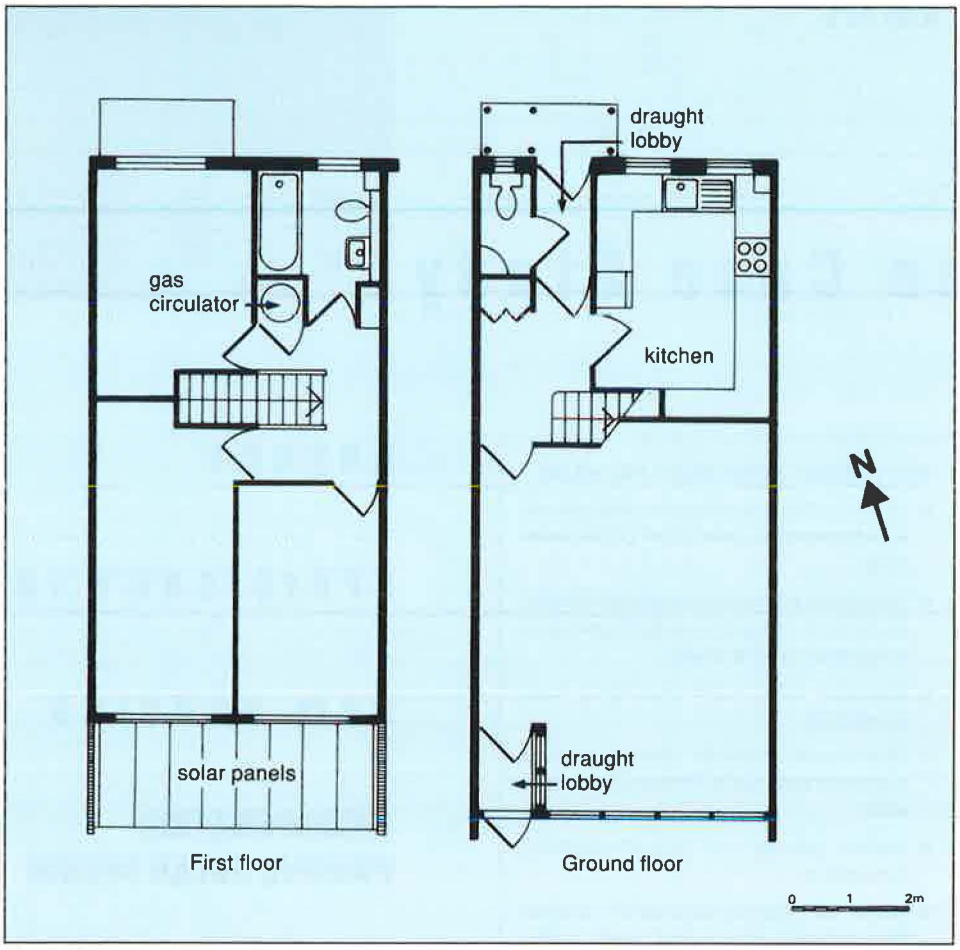
- a 5m^2 area of solar water heating panels installed over each sunspace extension, forming a 45° mono-pitch roof.

The scheme was designed to take maximum advantage of the good solar access on the site as well as to have a low heat demand.

Lawrie Park from the north

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

(W7)
CI/SfB 1976 81 (56.15) (R5)



Typical 6 person floor plans

SITE PLANNING

The houses are arranged in three terraces, orientated so that the living areas face south. The terraces are positioned to minimise overshading.

The existing trees in the centre of the site were retained because, being deciduous, they were thought to provide useful summer shading for only a relatively small obstruction to the low angle winter sun.

DESIGN AND CONSTRUCTION

Insulation levels which are generally better than those set by 1990 Building Regulations are incorporated into all external building elements:

- Roof: trussed rafter with 200mm mineral fibre insulation, U value = 0.18 W/m^{2}K.
- Ground floor: concrete beam and block with 19mm expanded polystyrene, U value = 0.50 W/m^{2}K.
- Walls: lower storey, 50mm cavity insulation, plus 25mm dry lining, U value = 0.38 W/m^{2}K.
- Upper storey: foam filled blockwork plus 25mm dry lining, U value = 0.50 W/m^{2}K.
- Windows: double glazed, draughtstripped, with trickle ventilation, U value = 2.50 W/m^{2}K.

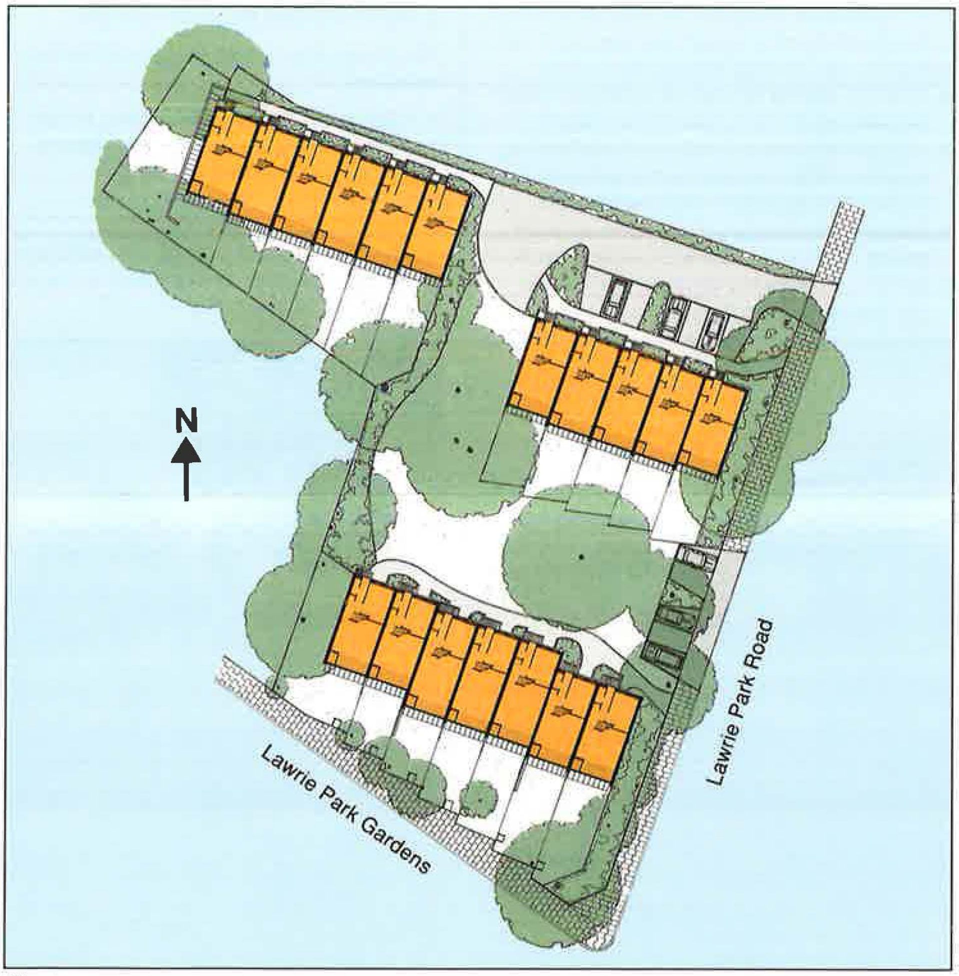
Direct solar gain is collected through the large areas of vertical south facing glazing. Solar gains warm the air in the living room and are also stored in the surrounding walls and floor. The higher than average radiant temperatures of the sunspace surfaces are designed to improve thermal comfort and reduce the need to raise the air temperature using the heating system. The sunspace areas have bare brick walls and uncarpetted ceramic tiled floors to increase the thermal storage capacity. This gives them a slow warming and cooling rate to help smooth temperature fluctuations and contribute to a stable and controllable environment. The rest of the construction is conventional with no particular measures to increase thermal mass.

During summer months when the sun's elevation is greatest, the majority of solar energy incident on the sunspace is collected by the sloping roof of water heating panels. Hence the opaque panels also protect the sunspace from glare and overheating. A thermosyphon system naturally transfers heat from the panels to a cylinder in the roofspace whenever the temperature of the panels rises above that of the cylinder. This cylinder provides preheated water to a gas fired storage unit which feeds hot taps. Solar heated water can also be drawn off directly via a third tap installed on sinks, baths and basins.

Ventilation control is an integral part of the overall strategy. All external doors have draught lobbies. Windows and doors are fully draughtstripped. All door and window openings and services puncturing the building envelope are caulked. Permanent background extract ventilation is provided in kitchens and bathrooms and their doors are draughtstripped so that it is possible to contain the moisture generated in these rooms and remove it at source.

Trickle ventilators were fitted to window heads. These were sized at 4000mm^2 for kitchens and bathrooms and 2000mm^2 for all other rooms.

The gas fired warm air heating system takes fresh air from the roofspace in order to recover



Site layout

any heat that may have accumulated in the loft. This is mixed with recirculated air, heated, and distributed to all rooms via ducts.

Combustion gases are exhausted to the outside via high level roof outlets.

The unit recycles return air from all rooms except the kitchen and bathroom. Therefore some of the heat that often builds up in one part of a house due to stratification or gains from the sun, occupants and appliances is redistributed around the house to reduce temperature variations between one room and another. The positive pressure created in the kitchen and bathroom assists in driving moisture out of the house.

MODELLING

SLC used their in-house computer software to evaluate various potential energy efficiency measures so as to arrive at an optimum package for the scheme. The houses were predicted to produce a 61% saving in space heating consumption over their 1982 Building Regulation equivalent.

BUILDABILITY

The warm air heating system required extra supervision to ensure ducting was properly installed. In places the ducting size varied, restricting outlets, and in others did not marry up with outlet grilles.

One house was pressure tested for airtightness, an equivalent natural air change rate of 0.9 ach was indicated. After various leakage paths were found and sealed, further testing showed that this had been improved to 0.6 ach against a design target of 0.5.

THE BUILDABILITY FAULTS

1 Loft hatches not draughtstripped or fastened.
2 External doors not draughtstripped.
3 Bathroom and kitchen doors not draughtstripped.
4 Extra, unspecified trickle ventilators had been fitted.
5 The conservatory style glazing had large gaps between frames and subframes.
6 A service duct had been designed in such a way as to create an air path between the kitchen and the roofspace.
7 Joints between back door frames and walls were deeply raked, allowing air ingress.
8 There were gaps between first floor partitions and ceilings allowing air to escape into the roof space.
9 The place where the heater flue and inlet passed through the ceiling had not been sealed and insulated.

The stringent draughtstripping measures proved difficult to supervise; in some places draught stripping had visibly been omitted, in others it was only detected using a smoke test. Even though these problems were remedied in retrospect the experience highlighted the difficulties of picking up insulation and draughtstripping faults. The SLC Energy Group have therefore adopted a separate inspection procedure for energy related measures on all their schemes.

Sunspace area

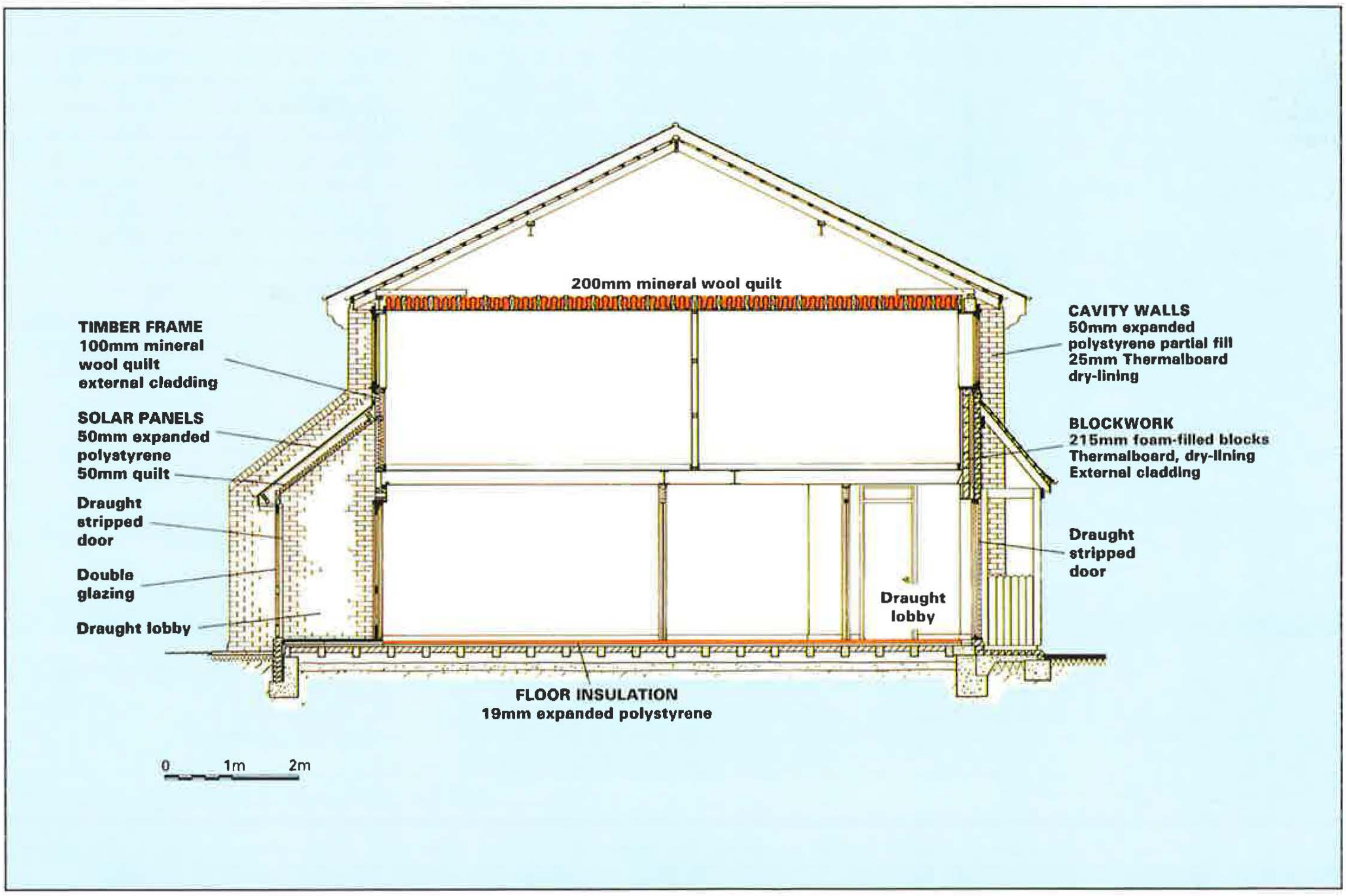
The larger than usual areas of south facing glazing, the sunspaces, and solar panels caused no additional complications to the builders.

MONITORING

Each of the houses was monitored in detail between June 1984 and December 1985. Measurements (taken every two seconds and averaged hourly) included:

- temperature in each room
- heating 'on' time
- fuel consumption
- window opening time
- external temperature (air and ground) and wind conditions.

Monitoring showed occupancy levels were lower than expected, 3 to 5 people instead of 5 to 6 per household, producing lower levels of incidental gain than anticipated. Internal temperatures were maintained at an average 21.2°C during heating periods rather than the 18.3°C used in the computer predictions.



Cross section

LAWRIE PARK ROAD

ENERGY AND COST SAVINGS

Monitoring showed that the houses have an average space heating consumption of 8,240 kWh per annum, which was calculated to be a 60% saving over an equivalent house built to 1982 Building Regulation thermal standards. (Approximately 50% compared to 1990 Building Regulations).

The space heating efficiency measures were estimated to have a simple payback period of 4.9 years.

Useful solar energy provides 16% of the total space heating requirement.

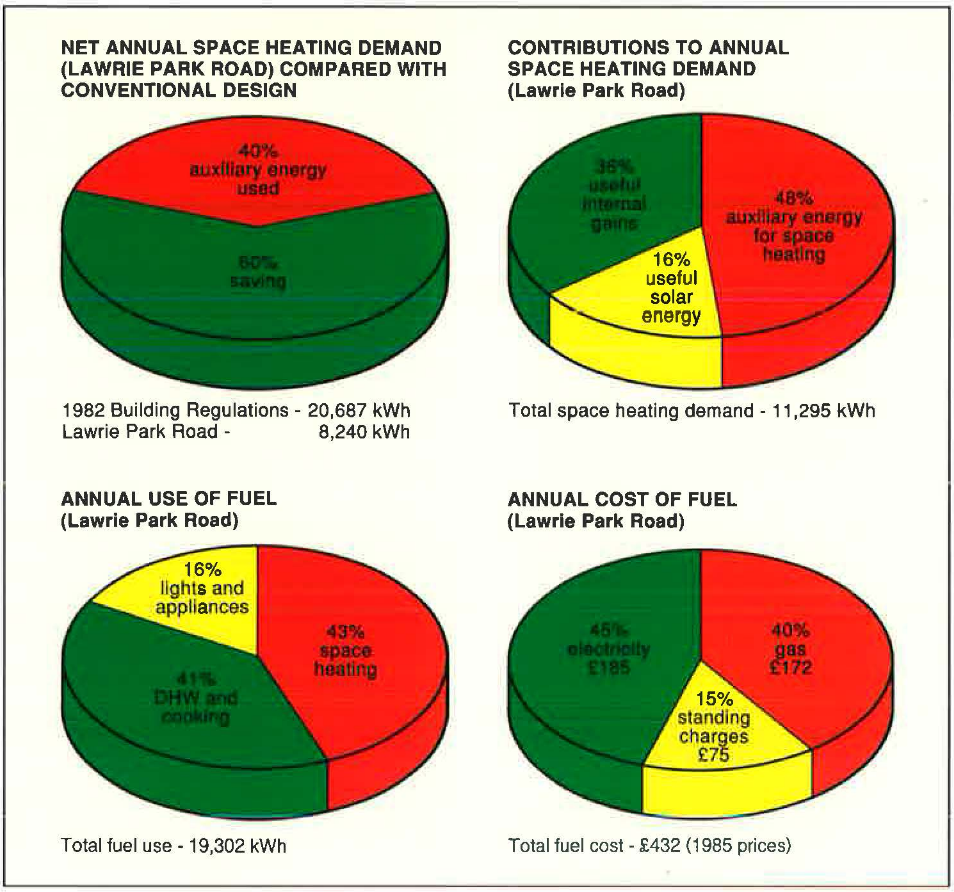
The experimental solar water heating panels are estimated to save 40% of the water heating fuel costs, worth £50 per year.

In total, the houses cost around £432 per year to run. Total gas consumption for space and hot water heating and cooking costs around £172, or only 40% of the total.

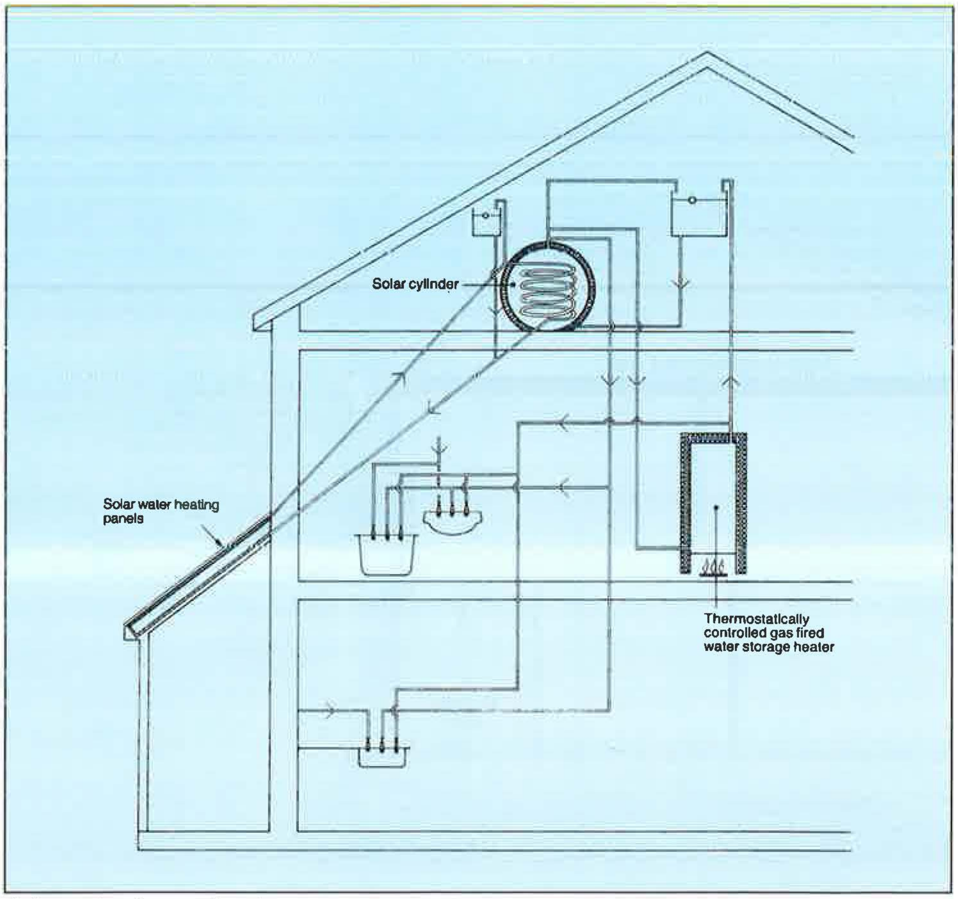
BUILDING COST

Compared to the then current 1982 Building Regulation requirements, increased insulation, double glazing throughout, and draughtstripping cost an extra £1,218. This was offset by a £544 saving due to the smaller heating system required. The net cost of the package was, therefore, £674 per house (at 1985 prices).

This does not include the solar water heating panels which were too expensive to justify on cost grounds alone.



Energy use and fuel costs



Schematic of water heating system

ENVIRONMENTAL IMPLICATIONS

Energy use in dwellings accounts for around 28% of Britain's total emissions of carbon dioxide (CO_2), the principal greenhouse gas. The average household releases 8.1 tonnes of CO_2 into the atmosphere each year.

The reduction in gas consumption due to just the cost effective measures also produces a reduction in CO_2 emissions of 1.63 tonnes per year for each house. (Compared with the same house built to 1990 Building Regulations).

ASSUMPTIONS

Unit fuel costs: Gas - £0.011 per kWh (1985).

CO_2 emission: each kWh of gas (delivered) releases 0.2kg of CO_2 into the atmosphere.

Host organisation
London Borough of Lewisham,
Architects Department
Capital House, 47 Rushey Green
Catford, London SE6 4BA
Tel: 081 697 9111
Contact: David Butterworth.

Energy advice and monitoring
South London Consortium
Elgar House , 41 Streatham High Road
London SW16 1ER
Tel: 081 769 9000
Contact: Dr Lali Makkar.

Further information on this or other building-related projects, please contact: Enquiries Bureau, Building Research Energy Conservation Support Unit (BRECSU), Building Research Establishment, Garston, Watford, WD2 7JR. Tel No. 0923 664258. Fax No. 0923 664097.

For further information on industrial projects, please contact the Energy Efficiency Enquiries Bureau, Energy Technology Support Unit (ETSU), Building 156, Harwell Laboratory, Oxon OX11 0RA. Tel No: 0235 436747. Telex No: 83135. Fax No: 0235 432923.

Printed in the UK for HMSO Dd.8396699, 1/93, C30, 38938