Solar house checked out

Discussions about reducing the amount of energy we use often seem to create a sense of helplessness — there's so little that the individual can do to help. Yet about one-eighth of the nation's consumption goes on space heating, lighting, and heat for cooking and hot water in the home. That's a considerable fraction, and here perhaps the individual may be able to play his or her part.

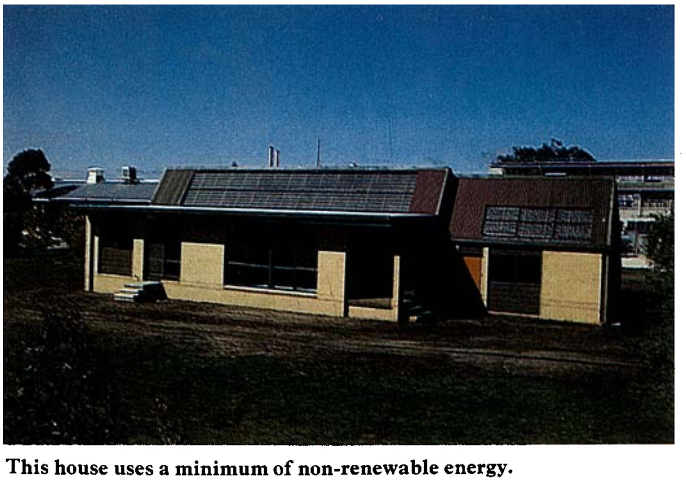
In southern Australia space heating accounts for almost half of the energy used in the home — the figure varies only marginally for locations in Tasmania, Victoria, and southern New South Wales. (In the warmer State of Queensland it drops to only about one-tenth.) Burning increasingly scarce oil and natural gas provides most of this heat, and it should be possible to cut both this demand for space heating and that for heating water by using solar radiation, insulation, and good design. But by how much?

A new house just completed for CSIRO in Melbourne should help give the answer. This house has two purposes — to demonstrate how good design can keep capital costs and energy use down, and to act as a test bed for experimental features. The house is based on a standard Jennings 'Berkshire' floor plan, but it has been modified by the CSIRO Divisions of Mechanical Engineering and Building Research in consultation with Jennings Industries Ltd. Mr Mike Wooldridge of the Division of Mechanical Engineering has acted as project coordinator.

The design includes a solar air-heating and heat-storage system, a solar hot-water system, and such features as large glass windows on the northern side to let in as much heat as possible in winter, wide eaves (to keep it out in summer), and a garage located on the western side to keep off the late afternoon sun. The idea is to compare the day-to-day energy costs of this house with those of several standard 'Berkshire' homes situated in the Melbourne suburbs.

Unlike these four standard homes, the CSIRO house won't be inhabited by people. Instead a microprocessor will imitate people's living patterns by opening and closing doors, windows, and curtains, turning taps and the kitchen stove on and off, and generally doing all the things that people normally do to create and let out heat during the 24 hours of the day. Information about the energy used will be automatically monitored for 24 hours each day for 2 years.

Building the house required use of only those building materials that were readily



This house uses a minimum of non-renewable energy.

available and techniques that would be understood by normal tradesmen. It will thus be possible to relate the experience gained from building and operating this house to everyday life. Even the novel solar space-heating system was made from standard aluminium roof sheeting and standard acrylic roofing sheets.

Main design features are:

- solar heating systems for providing space heating and hot water
- a massive floor that will absorb and store heat in winter and keep the house cool in summer
- well-insulated walls and ceilings to keep winter heat losses and summer heat gains as low as possible.
- careful positioning on the block to make best use of the sun
- large windows on the northern side to let in as much solar radiation as possible in winter

The solar hot-water system used absorber plates from a commercially available type. Its 4·5-sq-metre collector, which is on the garage, is connected to a 315-litre (70-gallon) tank.

Solar air space-heating and storage systems are not yet commercially available. The one for the CSIRO house consists of a very large 19-sq-metre solar collector that forms much of the roof on the northern side, and a concrete floor laid on a half-metre-thick bed of crushed rock.

A fan blows hot air from the solar collector through pipes located in the rock bed beneath the floor, which is thus warmed and hence transfers heat to the room above by convection and radiation. Air from the collector circulates through the heat store and back to the collector in a closed circuit. The designers expect the stored heat to keep the house warm for 3–4 days (it's rare for the sun not to shine at all for periods of more than 24 hours in Melbourne).

During hot weather, blowing cool air through the rock bed at night will help to keep the daytime temperature down.

The large solar collector is inclined at 58° to the horizontal to make best use of the winter sun. This rather steep angle gives the house an unusual asymmetrical roof-line, but its designers have come up with an acceptable result.

The absorber itself is made from two sheets of ribbed aluminium roof cladding (which can be purchased off the shelf) pop-riveted face to face. It thus consists of a row of rectangular-shaped ducts through which air can be drawn. The front and internal faces of the aluminium sheets are painted black, and the whole assembly is mounted on an insulating layer of fibre glass. A clear acrylic plastic sheet protects the front face of the collector.

The design of the rock-bed heat store is new. For many years the Division has used a somewhat similar system in its laboratory workshop building. However, this unit is not located beneath the floor, and it has a storage time of several weeks, compared with the 3–4 days of the new system. Another rock-pile unit, which was also designed by the Division of Mechanical Engineering, keeps the herbarium at the Waite Institute in Adelaide warm.

The heat store beneath the new house is probably more sophisticated than a normal suburban home would need. It's divided into two parts, the first being located under the living area and the other beneath the bedrooms. The slab under the living area is heated first, and when it reaches a set temperature the heated air is automatically switched over to the second one.

As the second slab is only being warmed by excess hot air it will not always keep the bedrooms warm. Quite possibly, the normal suburban home would not require this second heat store, since with good design the chill could be taken off the bedrooms by using such tricks as leaving the doors open. Dispensing with the second rock bed would certainly reduce the capital cost.

Between 7 a.m. and 11 p.m. the house will be maintained at a comfortable living temperature of 22°C. There will be times when the heat store will not be able to keep the house warm enough, and a small electric convection heater (probably 2·4 kW) will be used to provide a back-up.

Solar air-heaters have a major advantage over the more usual systems that transfer heat using water — they will not be so prone to leakage. However, the designers of the house have left their options open by installing pipes that will allow the heat store to be heated using water rather than air. Later on they may also try using other storage systems — such as a rock-pile store located in the garage.

Meanwhile the project's team of scientists will themselves be living in the house for a few days before turning on the monitoring equipment — just to make sure that their automatic control system really does mimic human habits and needs for comfort.

'CSIRO Low Energy Consumption House.' (CSIRO Division of Mechanical Engineering Information Service: Melbourne 1978.)