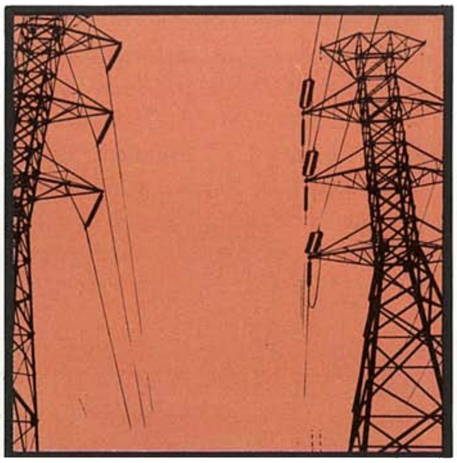
Outlook



Saving energy at home

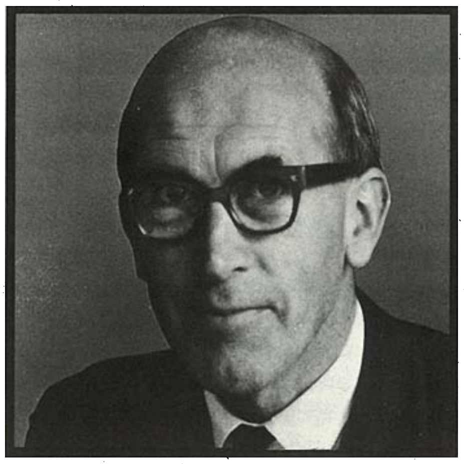
The world will use about 10 times more energy this year than in 1900—a somewhat spectacular statistic. But the era of cheap fuels seems to be drawing to a close, and possibly with it the era of ever-expanding energy use. Rising prices and the possibility of future scarcity are forcing people to look for ways to reduce their demands for energy.

'Belt-tightening' and 'leak-plugging' are the two approaches open. Belt-tightening involves sacrifice: a reduction in performance accompanies the reduction in energy use. Setting the thermostat of a house heating system at a lower temperature is a belt-tightening exercise. With leak-plugging, energy use falls but the old level of performance remains. An obvious example is reducing heat loss by insulating a house's walls and ceiling.

The areas where savings of energy could be achieved are probably as many as the uses made of it. For the individual, perhaps as good a place as any to start cutting back is at home. Mr Ron Ballantyne of the CSIRO Division of Building Research at Highett, Melbourne, recently examined the amounts of energy used to build houses and keep them functioning. His study points to many opportunities for reducing energy use without having to resort to belt-tightening.

Mr Ballantyne began by drawing together recent estimates, made independently by five research teams, of the amounts of energy used to make building materials. Although some of the estimates vary widely, metals and plastics turn out to need on average about 10 times as much energy per unit mass as bricks and up to 100 times as much as timber and concrete. Aluminium has the biggest energy requirement—perhaps 500 times that of timber and at least four times that of steel, copper, zinc, and lead.

The next step in the study was to relate these energy figures to the materials that go to make a typical house. Mr Ballantyne looked at a brick-veneer house and found that the bricks accounted for just over half the energy used to make its components. The roof tiles accounted for about one-fifth, and the concrete floor slab for about one-eighth. The contributions of all other materials were small by comparison.



Mr Ballantyne.

The total energy cost of materials turned out to be about 150 000 megajoules. This compared with an estimate of only about 10 000 megajoules for transporting materials to the site and actually building the house. The next stage of the study suggests, however, that the energy consumed in making a house is only a fraction of that used in the house during its lifetime.

Living with energy

Mr Ballantyne drew on energy-use and housing statistics to estimate that the average energy consumption per occupied dwelling in 1971 was about 83 000 megajoules. This indicates that, in only about 2 years, the energy used in servicing a dwelling mounts up to the total used to make it. If 40 years is assumed as the lifetime of a house or flat, something like 20 times more energy will be used in it than to produce it.

After only about 2 years, the energy used in servicing a dwelling mounts up to the total used to make it.

So, while many opportunities undoubtedly exist to save energy by choosing some building materials in preference to others, the scope for savings is much greater once the dwelling is occupied.

About half the energy used in houses and flats in Australia goes towards heating them. The other half is divided almost evenly between water heating on the one hand and cooking, lighting, and operating all forms of household devices on the other. A small but growing amount of energy is used for cooling houses and flats.

Space heating, as the main energy consumer, offers the biggest opportunities for cutbacks. Obvious ways to reduce the need for heating include using thermal insulation in walls and ceilings and designing buildings so that they take in large amounts of heat from the winter sunshine. Experience is now showing just how effective these approaches can be. For example, it appears that ceiling insulation typically reduces heating fuel needs by about 30%.

A group led by Mr Ballantyne recently devised computerized techniques for working out how changes in building design affect interior temperatures. Information on the thermal properties of a building's walls, floor, roof, and windows is fed into the computer. Also needed are measurements, preferably made hourly over several years, of outdoor temperature, direct and diffuse solar radiation, wind velocity, and cloud cover.

This is a vast amount of data, but not too much for today's computers to handle readily. The output shows the temperatures that can be expected inside the building throughout the year. These can be printed out in the form of grids, which show how often temperatures regarded as unacceptably high or low will occur (see the diagram). The amount of heating or cooling likely to be needed in a year, and the capacity of heaters and coolers needed to cope with the worst conditions, can also be shown.

As you like it

Quite a lot of effort has been put into discovering just what are acceptable indoor temperatures. The method has been to ask groups of people to describe their reactions to different temperatures in terms such as much too cool, too cool, cool, neutral, warm, too warm, and much too warm.

For climates like Melbourne's, scientists at the Division of Building Research have found that the point where most people's description changes from too cool to cool turns out to be about 15°C in winter and 17° in summer. From cool to neutral it is about 18° in winter and 20° in summer, from neutral to warm 23° and 25° respectively, and warm to too warm 26° and 28°. The most popular temperature in winter is 20·5°C and in summer 22·5°. Mr Ballantyne suggests that people tend to like it to be hotter indoors in summer than in winter because they wear fewer clothes in summer.

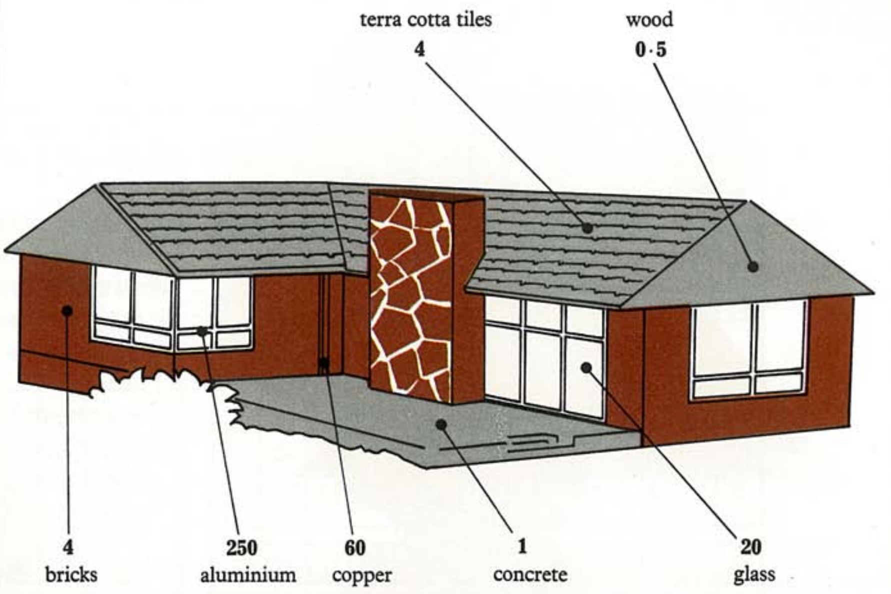
In an experiment with his temperature-predicting system, Mr Ballantyne fed data for a typical brick-veneer house with tiled roof and timber floor, situated in Melbourne, into the computer. The output showed temperatures that could be expected inside the house if it had no insulation and if the ceiling was insulated. The differences were small: insulation reduced the maximum temperature that could be expected in a year by only 2°C.

But heating and cooling requirements turned out to be much smaller in the insulated house. To heat to 20°C and cool to 23°C, the energy saving with 50 mm of ceiling insulation averaged 27% for heating and 37% for cooling. With 100 mm of insulation, the equivalent figures were 32% and 44%. Wall insulation would give further savings.

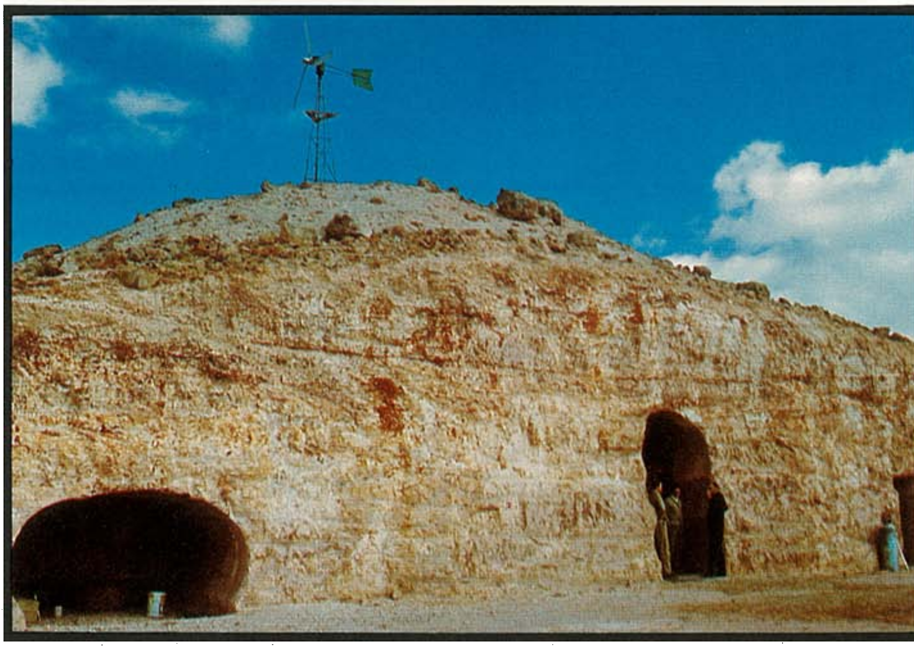
Direct from the sun

Mr Ballantyne believes that sun-powered air conditioning is some way off still, but he points out that buildings designed to take advantage of the winter sun need less additional heating. Scientists at the Division of Building Research have produced tables giving sun angles, solar

Energy used to make building materials



The figures are estimates (in megajoules per kilogram) of the energy needed per unit mass to make some building materials.



This dugout house at Coober Pedy in South Australia's desert aims for maximum protection from the sun.

These flats in Canberra have big windows to take advantage of the winter sun.

Two of Mr Ballantyne's temperature prediction print-outs

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
midnight	21°	21°	20°	17°	13	12	11	12	13	15°	17°	19°
3 a.m.	19°	19°	18°	15	12	10	10	11	12	13	15°	17°
6 a.m.	17°	18°	16°	14	11	9	9	9	10	12	14	16°
9 a.m.	19°	19°	17°	15	11	9	9	10	11	14	16°	17°
noon	22°	22°	20°	18°	14	12	11	13	14	17°	19°	20°
3 p.m.	25°	25°	22°	20°	15	14	13	15	16°	19°	21°	22°
6 p.m.	26°	26°	24°	20°	16°	15°	14	16°	17°	20°	22°	23°
9 p.m.	23°	23°	21°	19°	15	14	13	14	15°	17°	20°	21°

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
midnight	15°	16°	18°	22°	24°	26	29	30	27°	23°	18°	15°
3 a.m.	14°	14°	16°	20°	22	23°	26	28	24°	21°	17°	14°
6 a.m.	13°	14°	15°	19°	20°	22°	24°	26	23°	20°	16°	14°
9 a.m.	13°	13°	15°	19°	21°	23°	25	27	23°	20°	16	13°
noon	14°	16°	18°	22°	24	27°	29	30	27	23°	18°	15°
3 p.m.	16°	18°	21°	25	27	30	32	33	30	26	20°	17°
6 p.m.	18°	20°	22°	26	29	32	34	35	32	28	22°	18°
9 p.m.	16°	18°	20°	24	27°	29	32	33	29	25°	20°	17°

cool — unacceptably cool — warm — unacceptably warm

The charts show temperature predictions in degrees C—at 3-hour intervals each month—for a room in a typical brick-veneer house in Melbourne. The chart on the left shows temperatures that should be equalled or exceeded on all but 3 days in the month. The one on the right shows temperatures that should be equalled or exceeded on only 3 days in the month.

heat gains through glass, and other information that can help designers make the most of the sun.

As might be expected, measurements show that large glass areas in walls facing north make big contributions to winter heating. Mr Ballantyne points out that eaves and other sunbreaks can be easily designed to shield these areas from direct sun in the summer. Scattered solar radiation can still be a problem, providing unwanted heat through the glass. But blinds can control this. They are preferable to tinted glass, which blocks the sun's rays when they are wanted as well as when they are not.

If the winter sun shines onto material with a good capacity for storing heat, the solar contribution increases further. Dark-coloured heavy-weight floors or walls are good heat absorbers and stores. When the sun stops shining into the room and the air temperature begins to fall, the stores gradually release their heat.

Reducing the amount of air coming into and leaving a house is another rather obvious way to cut back the need for heating and cooling. Mr Ballantyne says tests show that the minimum ventilation needed to control odours will under normal circumstances provide more than enough oxygen for the people inside.

Fans can reduce the need for cooling. Experiments show that the temperatures people prefer rise with increasing air speed. However, they also show that the acceptable range of temperatures decreases as the air speed rises; people are more sensitive to temperature change when air is rushing past them.

After space heating, water heating is the biggest domestic energy user. Electrically boosted solar water heaters have been available for many years, and they reduce fuel use greatly. In northern and inland areas of Australia, hardly any electrical boosting is needed to keep up the hot water supply. In Melbourne, only about 40% of a year's heating is done by the boosters.

Solar hot water systems are more expensive to instal than conventional systems, but they are cheaper to run. As fuel costs rise, they will become increasingly attractive economically.

Mr Ballantyne points out that another way to reduce fuel needs for water heating is by reducing the use of hot water. He suggests that one of the most effective methods is to instal flow-restricting spray shower heads. These apparently satisfy the psychological requirements of shower-users. Similarly designed spray taps for hand basins would also cut back on hot water use. So would use of cold water for clothes- and dish-washing.

Turning to other smaller uses of energy in the home, Mr Ballantyne says savings could be made by installing fluorescent lights wherever feasible. They have higher luminous efficiency than incandescent light bulbs. He also points out that cooking on open hot plates is very inefficient.

More about the topic

Energy costs of dwellings. E. R. Ballantyne. *Proceedings, Fifth Australian Building Research Congress, Melbourne 1975* (in press).

Climatic design data and the effect of climate on indoor environment. E. R. Ballantyne. *Australian Refrigeration, Air Conditioning and Heating*, 1975, **29**, 20–30.