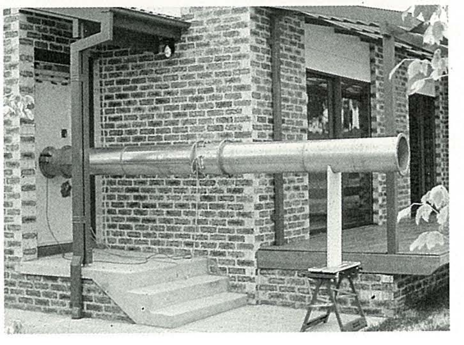
How draughty is your home?



A fan set in the tube allows the leakiness of a house to be measured.

If the wind whistles through your house when it blows, you could, during winter in southern Australia, be losing 20% of your precious heating energy. Most householders recognize the benefits of insulating, but not so many are aware of the heat escaping through the crack under the door.

On the other hand, if you seal up your house like a spacecraft, you could finish up having problems with 'indoor pollution' — a surfeit of carbon dioxide, moisture, or body odours. Kitchen smells or tobacco smoke may also cause problems. You need some fresh air, to prevent unhealthy stuffiness.

The problem with nearly all houses is that they rely upon natural air infiltration to supply the necessary ventilation. Air leakage through ventilators, cracks around windows, under doors, and other openings is pretty haphazard.

Researchers have found that, while wind speed has the largest impact, wind direction and the temperature difference between inside and out can also influence the leakage rate. In countries with more rigorous climates, houses are made much more air-tight, and fans are used to provide a controlled amount of outside air where and when it is needed.

Mr Don Michell and Mr Ken Biggs, of the CSIRO Division of Building Research, have measured the air-tightness of 29 Australian houses, and found that this property varied quite widely, but on average the houses were considerably more leaky than houses in countries with more severe climates. The average modern house in Britain or the United States is nearly twice as air-tight as the conventional project houses the CSIRO scientists measured. Swedish houses are close to seven times less draughty than ours.

Mr Michell and Mr Biggs have gathered the first such figures to be obtained for Australian houses. They measured 11 Victorian project homes (including two having low-energy designs), 12 solar houses at Bonnyrig, N.S.W., two standard Housing Commission homes at Bonnyrig, a CSIRO-designed solar house, and a single-roomed brick-veneer building at the Division's site at Highett, Vic.

From this limited sample, it seems that few houses come near the internationally accepted optimum ventilation value of one air change every 2 hours, which nicely balances freshness against energy loss. Some of the solar houses studied, when fully shut, tended to be on the stuffy side — as low as one air change every 4 hours — whereas the conventional houses tended to be draughty — about one air change an hour. (These figures refer to standard test conditions, described below. Actual air-change rates vary greatly.)

Leakiness was measured in two different ways: using a fan or a tracer gas.

The fan method

In the first, the researchers used a fan in a duct clamped to a panel inserted in an external door opening, and they determined the rate of air flow required to maintain a certain pressure difference (50 pascals is standard) between inside and out. This air-flow rate, divided by the building's volume, expresses the leakiness in air changes per hour.

One air change every 2 hours nicely balances freshness against energy loss.

The measurements are made with the external doors and all windows shut, and all internal doors (except that of the toilet) open. Exhaust fans and ceiling vents are sealed — and so are chimneys, vents on heating appliances, and the manhole cover — but wall ventilators are left open.

The leakiness values for the Victorian project homes and those for the two New South Wales Housing Commission ones were quite similar — about 24 air changes per hour.

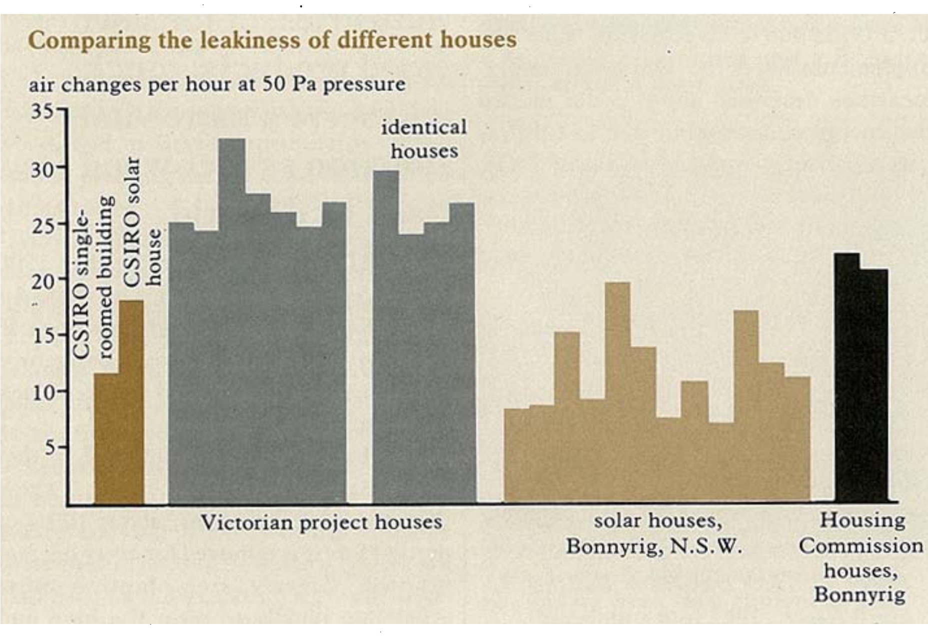
Remember that this figure refers to a pressure difference of 50 Pa; a strong wind (about 12 metres per second or 45 km per hour) would be required to raise such a pressure. In addition, the wind's effect works on only two walls of the house, whereas the test does it on all the walls, floor, and ceiling. In practice, the test-derived numbers can be divided by about 25 to give a rough idea of the air-change rates experienced with Melbourne's average wind speed (3·5 m per sec.).

Figures for the solar houses were more variable, but clustered around 12 air changes an hour.

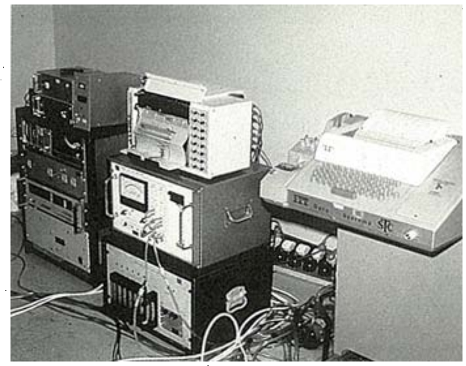
Values quoted for other countries include Britain 14, America 13, Canada 4·4, and Sweden 3·3–4·5, using the same test conditions.

The figures, although obtained under artificial conditions, do allow one house to be compared with another. The bar chart shows the comparison. Further investigation by the research pair in the single-roomed brick-veneer building at the Division revealed that the principal sources of air leaks were (in order): windows, external doors, fixed ventilators, and cracks between skirting board and floor.

One test with the apparatus showed that leakage around a door already fitted with a rainproof seal at the bottom could be reduced from 142 cubic metres per hour to 24 cu. m per hour (at a pressure difference of 50 Pa) by fitting a standard nylon-pile weather seal strip.



Solar houses show up less leaky than conventional ones. The measurements are made with a fan pressurizing the house to 50 Pa; dividing the numbers by about 25 would give more realistic values.



A tracer gas, released and monitored by this equipment, allows the leakiness of a home to be measured.

Tests on different types of windows, all of about the same size, showed a striking variation of leakage between types. At 50 Pa pressure difference, a wooden awning window let through 190 cu. m per hour, a wooden sash-type 72, an aluminium sash window 60, and an aluminium horizontal sliding type 18. Only the last window satisfies the relevant Australian Standard for air-tightness.

The high permeability of one house was attributed to considerable gaps at the skirting board, and to many knot-holes in the uncarpeted timber floor. Differences

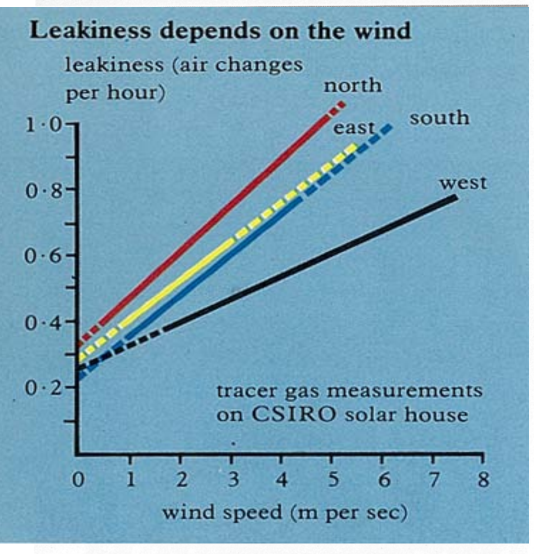
in the quality of the workmanship can make appreciable differences. Four houses of identical design, built by the one company, showed quite pronounced variations in their leakiness (from 24 to 30 air changes an hour).

Tracer gas method

The other method of putting numbers on a house's draughtiness uses a tracer gas, nitrous oxide. This gas can be released inside the house at a known rate and its concentration measured with equipment that detects the gas's infra-red absorption. The researchers modified the method so that the gas was released in 'bursts', the durations of which were adjusted so as to maintain a fixed concentration. Either way, the rate of dispersal of the gas is related to the rate of infiltration of air.

The method has the advantage that it measures air movement through a house under actual conditions. This means, of course, that data are needed on wind

Solar houses at Bonnyrig, N.S.W.



Both wind speed and direction affect the leakiness of a house.

strength and direction as well. To obtain representative figures, the equipment must continue to operate for a number of days, and this is the main disadvantage of the technique. It also requires stable weather conditions for periods of about an hour for each data point.

This complexity has meant that so far only four houses (three solar homes and the brick-veneer room) have been the subject of tracer gas measurements. For the standard wind speed of 3·5 m per sec. (at 10 m height) the infiltration rate varied between 0·25 and 0·8 air change an hour, depending upon house and wind direction.

Measured air infiltration into one of the houses is shown in the graph, where it can be seen that this quantity shows up as a straight line when graphed against wind speed. You can also see that the wind direction plays a large part in governing air inflow. This is due to asymmetries in the building, and to its orientation with respect to nearby sheltering trees and houses. It is therefore difficult, using the tracer gas method, to compare the infiltration rates of different houses, even when the wind speed and direction are similar.

Furthermore, the tracer gas results cannot be closely compared with the fan pressurization figures; there is no simple correlation between the two sets of data. However, both methods measure the effects of one cause — the holes and cracks in the building fabric; and so houses measuring high with one method should also show up as high with the other.

The researchers note that an air infiltration rate for one of the solar houses, of 0·25 air change an hour (measured by the tracer gas method), is probably unacceptably low, and consideration should be given to increasing the houses's ventilation. This would make sure oxygen and carbon dioxide levels were satisfactory, and reduce the risk of moisture and odour problems.

More commonly, though, Australian houses are likely to be leaky. Mr Michell and Mr Biggs suggest that the tightness of houses could be considerably improved, with relatively little outlay, by the following methods.

- Eliminate fixed wall ventilators in all rooms. In wet areas — bathroom, laundry, and kitchen — fans with shut-off louvres should be provided.
- Select window types that effectively seal when closed.
- Attach seals to all external doors, especially at the bottom, where the gap is often considerable.

How worth while these measures are depends on the severity of the winter. As an example, the energy required to maintain comfortable conditions in a typical house in Melbourne throughout the heating season is about 50 GJ and of this about 11·5 GJ is due to air filtration. Effective implementation of the 'house-tightening' measures described above could reduce the energy consumption due to infiltration to about 4·5 GJ, a saving of 7 GJ, which is around 15% of the average annual heating-energy requirement.

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More about the topic

Air infiltration and permeability measurements in some Australian houses. D. Michell and K.L. Biggs. *CSIRO Division of Building Research Report* No. 83/10, 1983.

An apparatus for air-tightness measurements on houses. D. Michell and K.L. Biggs. *CSIRO Division of Building Research Report*, 1982 (not numbered).