1978

VICTORIA

SECOND PROGRESS REPORT

FROM THE

CONSERVATION OF ENERGY RESOURCES COMMITTEE

UPON THE

USE OF INSULATION IN BUILDINGS

AND

CONSERVATION OF ENERGY GENERALLY

TOGETHER WITH

AN EXTRACT FROM THE PROCEEDINGS OF THE COMMITTEE AND APPENDICES.

Ordered by the Legislative Assembly to be printed. 16th May, 1978.

By Authority:
F. D. ATKINSON, GOVERNMENT PRINTER, MELBOURNE.
D. No. 1—5828/78—PRICE 90 cents

EXTRACTED FROM THE MINUTES OF THE PROCEEDINGS OF THE LEGISLATIVE COUNCIL

TUESDAY, 7TH MARCH, 1978

6. CONSERVATION OF ENERGY RESOURCES COMMITTEE.—The Honorable V. O. Dickie moved, by leave, That the Honorables V. T. Hauser, J. A. Taylor and I. B. Trayling be members of the Conservation of Energy Resources Committee.

Question—put and resolved in the affirmative.

EXTRACTED FROM THE VOTES AND PROCEEDINGS OF THE LEGISLATIVE ASSEMBLY

TUESDAY, 7TH MARCH, 1978

12. CONSERVATION OF ENERGY RESOURCES COMMITTEE.—Motion made, by leave, and question—That Mr. Amos, Mr. Cathie, Mr. Evans (*Gippsland East*), Mr. McClure, and Mr. Plowman be members of the Conservation of Energy Resources Committee (*Mr. Hamer*)—put and agreed to.

TERMS OF REFERENCE

JOINT SELECT COMMITTEE (CONSERVATION OF ENERGY RESOURCES) ACT 1976

SECTION 3

3. The functions of the Committee are—

(*a*) to inquire into and make recommendations on the extent to which energy resources in Victoria should be conserved, whether generally or in relation to particular resources ;

(*b*) to inquire into and report on ways and means of implementing those recommendations and in particular in relation to recommendations for the beneficial use of energy resources, to inquire into and report on what variations are necessary or desirable in—

(i) building designs, techniques and standards ;

(ii) the use of insulation in buildings ;

(iii) vehicle and engine design ;

(iv) transport systems ;

(v) industrial and manufacturing processes, methods, standards and plant ;

(vi) methods of promotion of the use of energy ;

(vii) other significant uses of energy ;

(*c*) to inquire into and report on the costs of and benefits to be gained from implementing those recommendations ; and

(*d*) to recommend what additional measures and programmes should be taken to encourage a responsible use of those resources.

SUMMARY OF RECOMMENDATIONS

Use of Insulation in Buildings:

(1) Ceiling and external wall insulation be mandatory for all future dwellings [para. 37 (*a*)] ;

(2) Ceiling insulation be strongly encouraged for dwellings erected prior to insulation being made mandatory [para. 37 (*b*)] ;

Financing Insulation Programme:

(3) The Government, either alone or in conjunction with the State Electricity Commission and the Gas and Fuel Corporation of Victoria, provide moneys to fund an insulation programme [para. 67 (*a*)] ;

(4) The State Electricity Commission and the Gas and Fuel Corporation of Victoria together administer a fund to finance loans for the insulation of residential dwellings [para. 67 (*b*)] ;

(5) A maximum loan of $300 for ceiling and $100 for wall insulation be provided by the scheme [para. 67 (*c*)] ;

(6) The loan amounts be reviewed annually in relation to costs [para. 67 (*d*)] ;

Standards of Insulation:

(7) There should be minimum values of overall thermal resistance for roofs and walls—

(*a*) for a dwelling with type I walls which have an overall thermal resistance less than 1·4 m^2K/W then the roof shall have a minimum overall thermal resistance of 1·9 m^2 K/W when calculated for heat flow up (winter) situation ;

(*b*) for a dwelling with type I walls which have an overall thermal resistance equal to or greater than 1·4 m^2 K/W, the roof shall have a minimum overall thermal resistance of 1·5 m^2 K/W when calculated for heat flow up (winter) situation ; and

(*c*) all type II walls of a dwelling shall have a minimum overall thermal resistance of 0·45 m^2K/W [para. 77. see also para. 76 for definitions].

Heating Swimming Pools:

(8) The installation of oil and gas heaters for domestic swimming pools be prohibited after 31st December, 1980 [para. 99 (*a*)] ;

(9) All domestic swimming pool owners be prohibited from using oil or gas for heating after 31st December, 1990 [para. 99 (*b*)] ;

(10) The use of thermal pool covers be encouraged by energy supply authorities [para. 99 (*c*)] ;

Community Education:

(11) The establishment of a seperate Office of Energy Conservation within the Department of Minerals and Energy to be the prime authority for the promotion of energy conservation by Government departments and instrumentalities [para. 102] ;

(12) Education programmes should encourage the community to voluntarily adopt a 90 k.p.h. speed limit [para. 110] ;

Government Example:

(13) Only light at night the section of a building that is actually being cleaned or used, not whole floors [para. 105 (*a*)] ;

(14) Only heat or light rooms when in use [para. 105 (*b*)] ;

(15) Thermostats controlling heating and air conditioning should be set at 20°C [para. 105 (*c*)] ;

(16) The Government, State instrumentalities and municipalities should purchase four cylinder vehicles where feasible [para. 108].

REPORT

1. Under the *Joint Select Committee (Conservation of Energy Resources) Act* 1976 (No. 8851), it is necessary for the Committee to be re-appointed each Session of Parliament. Accordingly, on 7th March, 1978, the Committee was re-appointed without any change in membership.

2. On the 5th May, 1977, a Progress Report upon the Use of Insulation in Buildings and Conservation of Energy generally (Victorian Parliamentary Paper, D. No. 21, 1976–78) was tabled. In that Report it was recommended that—(i) all future residential buildings should have both wall and ceiling insulation; and (ii) existing houses should have ceiling insulation.

Since tabling that Report, the investigation into insulation has continued in order that—(i) more specific recommendations can be made on domestic insulation; and (ii) a satisfactory method of financing housing insulation can be devised.

3. Appended to this Report is a list of witnesses (Appendix A) and a list of persons or organizations (Appendix B) who have presented submissions (1), together with Minutes of Evidence (1).

USE OF INSULATION IN BUILDINGS

4. Further evidence tendered to the Committee has reinforced its earlier belief that residential dwellings should be insulated.

All witnesses agreed that the proper insulation of dwellings could reduce energy consumption. However two witnesses opposed mandatory insulation.

5. The Master Builders Association of Victoria submitted that—

(i) mandatory insulation does not necessarily reduce energy consumption ;

(ii) education of the consumer is the prime factor in conserving energy ;

(iii) possible savings through insulation are negligible compared to losses through electrical generation ;

(iv) the efficiency of heating units should be upgraded ; and

(v) performance specifications for the building envelope should be prepared.

The Housing Industry Association opposed mandatory insulation on the basis that it would increase the cost of housing. This in turn would increase the deposit gap—the difference between the amount a person can finance and borrow and the total cost of his house and land—which many potential home owners already find a major barrier or obstacle in purchasing their own home. The Committee comments on this aspect later in this Report when discussing the financing of an insulation programme (see paragraphs 59 and 60).

6. Witnesses supporting insulation favoured a scheme whereby the householder would be able to obtain an interest free or low interest loan towards the cost of insulation. It was stated, however, that the average person in the street was not energy conscious and that the only way that many people would insulate their dwellings was if such were made compulsory.

7. The reflective foil laminate manufacturers summarized the Victorian climate by saying " no amount of insulation in a dwelling will remove the need to use energy for heating on some basis during winter, but a properly insulated dwelling need not require energy for cooling during summer ".

8. The Fibreglass Insulation Manufacturers' Association of Australia calculate that by insulating new dwellings alone, at current energy prices, savings of approximately $263 million could be made on heating in Victoria over the next fifteen years. The national savings on heating could be approximately $660 million over the same period. The Association calculated that an additional $40 million in Victoria or $230 million in Australia could be saved if cooling is taken into account. Combined savings on heating and cooling over the fifteen year period amount to $303 million for Victoria or $890 million nationally. If insulation were extended to existing dwellings then the possible savings would be even greater.

9. The Committee accepts that insulation can substantially reduce energy consumption. However, it is difficult to predict the extent to which savings will be made both financially and in the use of energy as a result of insulation because individual heating habits vary greatly. Some people heat the whole dwelling whilst others heat the living areas only and the hours of heating can vary from one or two hours a day up to continuous heating twenty-four hours a day.

(1) Submissions and Minutes of Evidence not printed.

10. The Committee agrees with the Master Builders Association on education of the consumer. In its Progress Report(2) the Committee made specific mention of education for the community and school children in paragraphs 52 and 53 which read—

> " 52. A general community education programme on energy conservation should be initiated as soon as possible. This should be the responsibility of the soon to be formed Department of Minerals and Energy and should be given a high priority.
>
> 53. In addition to a general community programme, the Committee believes that an educational programme on energy conservation designed specifically for school children should be instituted. The early savings from such a programme could be minimal, but the future savings could be very significant. If such a programme was very carefully designed and were to achieve the same success as campaigns such as " Don't Rubbish Australia ", the Committee believes that the State's conservation programme will be much more effective in the vital last two decades of this century."

11. The Committee agrees that heating units could be more efficient and that there should be a specified thermal performance for the building shell or envelope.

12. Representatives of the Royal Australian Institute of Architects and the Thermal Insulation Institute of Australia stated that orientation and siting of the dwelling on the block of land and the design of the house were also important. Other factors mentioned were the building materials used in modern conventional houses and the community's reluctance to change the appearance of houses.

13. Each of these aspects will be considered in future inquiries to be made by the Committee. From evidence received during this inquiry, it is obvious that insulation alone is not the complete answer to energy conservation in the domestic situation and high priority will have to be given to the inquiry into " building designs, techniques and standards ".

14. The Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) has carried out research which shows that the amount of energy required to heat a house can be reduced by up to 50 per cent. if the ceiling and walls of the house are insulated. The Gas and Fuel Corporation of Victoria and the Fibreglass Insulation Manufacturers' Association of Australia agree with this calculation.

15. The Gas and Fuel Corporation advised that the average operating cost per customer for domestic gas heating in 1976–77 was \$80.43. The average for gas space heating was \$71.40 and for gas central heating was \$147.00.

The State Electricity Commission advised that " for those dwellings using electricity as the main form of space heating, the estimated average annual expenditure is \$51. This figure reflects the high efficiency and controllability of electric heating and also the fact that most of the dwellings using direct electric heating only are flats which are, in general, considerably below the average dwelling size ".

As a result of studies made by the Commission, it further estimates that the average cost per household for space heating is \$83. This estimate covers several types of fuels (oil, kerosene, gas, electricity, briquettes, firewood) used for heating.

16. The Commission stated that the actual heating costs varied widely between individual dwellings because of type of fuel used, size of dwellings, percentage of dwelling heated, quantity of insulation (if any), design of dwelling, and the various comfort requirements of the occupants.

17. If every dwelling had both wall and ceiling insulation and actually achieved a 50 per cent. reduction in energy use, the 1976–77 average heating bill would have been approximately \$40 per household. The number of domestic dwellings in Victoria at 30th June, 1977, was approximately 1,262,321(3) From these figures it is apparent that approximately \$50 million could have been saved.

18. When calculating savings that could be made by insulating a dwelling, most witnesses regarded fifteen to twenty years as a reasonable period in which to recoup the insulation costs. Using the average heating bill of \$80, if savings of 50 per cent. were actually realized each year, over a fifteen year period \$600 in energy bills would have been saved. This is not allowing for increases in fuel charges during the fifteen years. With no allowance for increased fuel prices, and if savings of 25 per cent. were realized, \$300 would be saved over a fifteen year period. If the inevitable rises in fuel prices are taken into account, then the insulation costs become an even more attractive investment.

(2) op. cit.

(3) Preliminary figures, Australian Bureau of Statistics (Building Division).

19. The Committee has not been able to obtain statistics from any source giving details of the number of buildings in Victoria having ceiling and/or wall insulation. It has had to rely on the estimates provided by energy suppliers and insulation manufacturers.

20. The State Electricity Commission advised that from figures supplied by insulation manufacturers it is estimated that 260,000 Victorian dwellings have had their ceilings insulated during the period 1968–69 to 1975–76. However, no estimates were given for the number of dwellings insulated prior to 1968 and this figure does not take those dwellings into account.

21. The following table was compiled from figures obtained from the Australian Bureau of Statistics showing the number of new dwellings completed in Victoria over the past three years.

Year	Total No. Dwellings at 30th June	New Dwellings Completed			
		Private		Government	
		Houses	Other	Houses	Other
1974–5*	1,200,695	24,205	9,650	2,697	790
1975–6ϕ	1,229,894	23,342	7,720	2,793	450
1976–7ϕ	1,262,321	26,686	8,210	2,215	714

* Final figures. ϕ Preliminary figures.

22. Evidence given to the Committee indicates that 20 per cent. of new dwellings are insulated during construction. It can be seen from the above table therefore that in excess of 20,000 dwellings are being built each year in Victoria without any insulation.

23. In mid-1977, the Housing Commission announced the introduction of an insulation programme which would mean that all future Commission dwellings would have the ceilings insulated during construction. It was further stated that all existing Commission dwellings would have the ceilings insulated within a four year period.

24. Nearly all witnesses were of the view that people were gradually extending the comfort zones of their houses and that with increasing affluence, people were moving from heating the living area to heating the whole house (bedrooms, hallways etc.). Once again there is no statistical information available to guide the Committee.

25. It was suggested that some people who insulate would still spend the same amount of money on energy by extending the comfort zone of their dwellings.

26. The Committee believes that there are also other factors. With improving lifestyles and affluence, there are people who—(i) increase the comfort zones of their houses but still do not insulate them ; and (ii) increase their energy use regardless of cost. It is these people in the community that must be reached if worthwhile steps are to be taken to conserve energy.

27. In theory, savings of $50 million at current energy prices could be made in one year in Victoria if every dwelling had wall and ceiling insulation. Actual savings in the first few years are likely to be less than half those possible, but if conservation programmes are promoted, and individuals insulate their dwellings, and are educated in energy conservation, then optimum savings could be achieved.

28. The total number of dwellings in Victoria at 30th June, 1977, was 1,262,000 approximately. As mentioned earlier the Housing Commission has commenced a programme whereby all future Commission dwellings will be insulated. The number of private dwellings being constructed each year has averaged in excess of 24,000 houses and 8,000 flats/apartments over the past three years. If this average is maintained over the next decade, there will be approximately 1,612,000 dwellings in Victoria by June, 1988—an increase of 320,000 new dwellings (some 25 per cent.).

In other words, those dwellings built prior to June, 1978, will account for nearly 80 per cent. of the total number of dwellings as at June, 1988. Consequently they are also going to account for the majority of the domestic energy consumed over the next decade. If energy is to be conserved, existing dwellings cannot be overlooked.

29. The United States of America, New Zealand, the United Kingdom and several European countries already have regulations covering insulation of residential dwellings. Set out below is a table(4) showing the countries, the insulation requirements and whether or not the governments give tax or subsidy benefits.

Country	New Housing Insulation Requirements	E.B.C.* A & B	Incentives- subsidy, grant or loan	Total Government subsidy and promotion costs
Belgium	Not known, but presumably mandatory	A only –	25% subsidy for A up to $520 or $42 per inhabitant.	125 m. Belgian Francs ($2,583,000) for insulation and other improvements.
Denmark	Mandatory	A & B	25% subsidy for A & B, minimum $66 to maximum $666 per dwelling in case of A. Loans also available, and $20 m. for Government buildings.	300 m. Kroner ($40 million). for thermal improvements to dwelling built prior to 1963, plus $533,000 on promotion.
West Germany	Effectively mandatory	—	—	Heavy advertising, and letter-box drop campaigns covering 10 million households.
France	All new housing must meet a "G" coefficient - i.e. a maximum hourly heat loss.	A	1. Tax deduction for cost of thermal improvements including $165 per dependent. 2. Subsidies also available for thermal improvement on houses built prior to 1948	Total allowance not known, but considerable funds also expended on advertising.
Holland	Mandatory	A & B	33 1/3% subsidy on housing improvements costing between $150 and $300. 33 1/3% subsidy on other buildings on minimum. expenditure of $900.	145 m. Guilders for 1974/76 ($43,900,000) for thermal improvements plus expenditure on leaflets and advertising.
Sweden	Mandatory	A & B	Combination of grants, higher loans and other incentives. Direct grants of $364 for improvements to houses.	300m. S. Kroner ($54 million) for grants and loans in 1975.
United Kingdom	Mandatory	A & B	Small discretionary subsidy through grants for general improvement work.	5 m. pounds advertising campaign, 1974/75 ($7,700,000).
U.S.A.	Mandatory in some States* Mandatory for loan from Federal Housing Authority. *including California & Minnesota.	A	1. Direct grants to low income families for purchase of weatherisation materials. 2. Tax credit pending in Congress. 3. State tax exemptions, including sales tax.	1. US$165 m. over 3 years for low income families. 2. Large expenditure by Federal, State Governments and many power suppliers on conservation advertising.
New Zealand	Non-mandatory	A	Interest-free loan of $150 to $300 administered by power authority - for insulation only.	NZ$6 million.
Australia	Non-mandatory except some Govt. Housing	—	NIL	NIL

*Existing Buildings Covered:
A) dwellings
B) commercial and industrial

30. Since compilation of the table, the New Zealand Government has decided to make minimum levels of insulation mandatory for all new residential buildings.

31. In 1975, the New Zealand Government introduced an interest free loan scheme for insulation which provided loans of $150 for ceiling and $150 for wall insulation. The interest free repayments were to be made over a period of two years. This scheme was extended in 1977 to provide loans of up to $400 interest free for four years where new houses were completely insulated—ceilings, walls and floors.

32. The United Kingdom has a Department of Energy which is very heavily committed to energy conservation. The Department encourages industry to appoint energy officers whose task it is to advise on energy conservation measures. The Department also provides a subsidy (maximum 60 pounds—A$95) towards the cost of a one day visit to an establishment by an energy consultant.

Insulation is now being recognized as a considerable energy saver. In Britain it is estimated that almost half of the 14 million homes still have no ceiling insulation. According to the Department of Energy, 500 million pounds worth of energy would be escaping every year through the roofs of British houses.

(4) Thermal Insulation, Vol. 1, No. 4, August, 1976—result of survey conducted in 1976 by the Mineral Wool Manufacturers' Association of Australia, now the Fibreglass Insulation Manufacturers' Association of Australia.

33. The British Government recently announced a massive new commitment to energy conservation. The Energy Secretary said " the multi-million pound package would save the equivalent of about 10 million tonnes of oil equivalent a year by 1988. In the first four years alone the programme will involve expenditure of some 320 million pounds. The energy savings made under the 11 point plan are expected to be worth about 700 million pounds a year at current prices.

Briefly, the plan consists of—

(1) An expansion of the programme of industrial demonstration projects, for which an additional £2 million has been allocated for 1978–79, rising to £8 million in 1981–82.

(2) £4 million in 1978–79, and £5 million in each of the following three years, to be allocated on expanding the information and advisory services to industry.

The Government is allocating these funds to give direct encouragement to energy saving throughout industry by providing £6 million next year, £9 million in 1979–80, £11 million in 1980–81 and £13 million in 1981–82. The aim is to encourage only those energy saving measures which are economic and therefore benefit the consumer as well as the nation.

(3) A £5 million a year extension of the Property Services Agency's existing programme in the civil and defence estates.

(4) An additional £5 million in 1978–79 and £10 million a year for the following three years, for installing thermal insulation and heating controls in National Health Service buildings.

(5) An additional £10 million in 1978–79 and £20 million a year, for each of the following three years, on a similar programme in educational buildings.

(6) Additional funding, up to £7 million a year, to be made available to local authorities to secure additional necessary staff and for the installation of heating controls—precise sums will depend on discussions with the local authorities.

(7) A ten year programme to bring public sector dwellings up to a basic minimum standard of thermal insulation. Provision is being made for expenditure over the next four years at an annual rate of £28½ million. In addition £2 million a year will be spent on improving the insulation of Ministry of Defence dwellings.

(8) Proposals to introduce new building regulations requiring the provision of appropriate controls on heating systems.

(9) The establishment of a new Government advisory and training service to promote efficient energy management in non-domestic buildings. Half a million pounds a year has been made available for this purpose.

(10) Discussions between the Government and the motor industry on possible targets for raising the average miles per gallon achieved by new cars and on methods of achieving those targets.

(11) An additional £0·5 million a year to be allocated over the next four years on an information and publicity campaign aimed at persuading motorists to see that their cars are well maintained and to drive in more economical ways "(5).

34. The U.K. Energy Secretary also said " Energy conservation is not a matter for the Government alone. To achieve the potential savings in full will depend in large part on how far the private sector matches the steps we have embarked on in the public sector. High energy prices make conservation good sense for everyone "(5).

35. In Victoria, there is not the same need for insulation for heating purposes that there is in the United Kingdom. The Victorian climate is warmer and insulation should be considered from a cooling as well as a heating point of view.

36. Residential dwellings should be considered under two different categories—(*a*) those in existence prior to any future regulations requiring insulation being promulgated ; and (*b*) those commenced after insulation is required.

Those dwellings in the second category can have the walls and ceilings insulated very easily whilst those in the first can, generally speaking, only have the ceiling insulated economically ; in most existing houses, it is not really practicable to insulate the walls.

37. The Committee recommends that—

(*a*) ceiling and external wall insulation be mandatory for all future dwellings ; and

(*b*) ceiling insulation be strongly encouraged for dwellings erected prior to insulation being made mandatory.

(5) Energy Management, December, 1977. (U.K.)

38. In making these recommendations, the Committee has considered the question of health hazards of man-made fibres. In its submission the Environment Protection Authority stated " The possibility of lung injury due to inhalation of fine particles of this material (fibreglass) has been raised repeatedly, but to date there is no substantial evidence of pulmonary effects in man." Following receipt of this evidence, the Committee was concerned to see various press reports querying the health safety of this material. The Master Builders Association also wrote to the Committee expressing its concern at the potential health hazards associated with the handling and installation of man-made fibre insulation materials.

39. Before finalizing its recommendations, the Committee sought further information from the Environment Protection Authority and the Department of Health. The Authority felt that the situation had not changed since its earlier statement and the Department of Health agreed that no long term harmful effects of fibreglass have yet been demonstrated in humans.

40. Dr. Milne, Industrial Hygiene Division, Department of Health, appeared before the Committee and presented the results of research work which he carried out in France over the past two years on the health effects of man-made mineral fibres.

He advised that for the fibres to be dangerous to man, firstly they must be of a certain critical dimension—less than 1½ micro-metres (micron) in diameter and eight or ten microns in length which would not be visible to the naked eye—and secondly, they have to get into the lungs and reside there for a sufficient period to exert their effect. He further advised that because of the digestive system in man and the change of these glass fibres in tissue fluids, the present feeling among researchers is that given two or three years, the glass fibres would be destroyed in human lungs.

Dr. Milne admitted that he could not say that there was zero hazard but he believed that there is no hazard within a lifetime. He continued by saying " One can never say that there is completely zero hazard from anything. Any molecule stands the chance of affecting any cell but operating on a reasonable basis the incidence would be vastly less than walking into ordinary city air, i.e. the chances of developing bronchial cancer ".

FINANCING AN INSULATION PROGRAMME—COSTS OF INSULATION.

41. The Committee considered whether or not electricity and gas tariffs should be increased to serve a three-fold purpose—(*a*) to price energy more in line with world prices and the cost of replacing existing energy sources ; (*b*) to act as a disincentive to consumers to waste energy ; and (*c*) to raise funds to finance an insulation programme.

42. A change in the basic structure of tariffs would present some problems. At present there are two basic types of tariffs used in Victoria. With heating oil, the tariff, or cost per unit, remains constant irrespective of the amount of oil consumed. With electricity and gas there are variations.

43. The electricity tariff consists of a number of price blocks and is aimed at recouping in the first block the fixed cost of connecting a building to the supply system. The remaining two blocks are to cover the cost of producing the energy. The Commission has two tariffs—one (GC) for all-electric dwellings (refrigerator, permanently-wired cooker and hot water) and one (GB) for other consumers. Current charges (May, 1978) in the first two blocks of both tariffs are identical—for the first 90 kilowatt hours, 12·81 cents per kwh and for the next 450 kwh 4·08 cents per kwh. For all consumption over these 540 kwh, the all-electric tariff is 2·85 cents per kwh with the other tariff charging 3·31 cents per kwh. In effect, these tariffs mean that the more electricity used by the consumer, the cheaper it becomes.

44. The Gas and Fuel Corporation's tariffs have the same effect. Its tariffs consist of supply (service) charges and commodity (usage) charges and the gas appliances are rated on their total consumption of gas. The supply charge is made once per billing period and the commodity charge is at a set rate per unit consumed.

Gas space heaters are the largest consumers of gas and attract the lowest tariff (03) whilst gas cookers use the least gas and attract the highest tariff (01). Gas hot water heaters are on the middle tariff (02).

The current (May, 1978) commodity charges per megajoule are—

tariff 03—0·21 cents

tariff 02—0·28 cents

tariff 01—0·40 cents.

If a consumer has more than one gas appliance, the tariff is decided by the appliance rated as using the most gas. Thus an " all-gas " dwelling—gas heating, gas hot water and gas cooking—would be on tariff 03 and all gas would be charged at 0·21 cents per megajoule.

Although the individual tariffs are at a flat rate per unit consumed, there is a built-in encouragement to have all appliances use gas if there is to be at least one gas appliance installed.

45. A form of inverted tariff was considered by the Committee. An inverted tariff would allow a certain consumption at a specific rate and any extra consumption would be charged at a higher rate.

It was decided that not only would an inverted tariff be hard to arrive at because of varying seasonal demand, but also that it could not be applied universally without being unduly harsh on sections of the community.

46. Problems would be encountered where dwellings had all three sources of energy—electricity, gas and oil—because energy consumption would be spread through each of these sources and probably would not be unduly affected by an " inverted " section of the tariff. On the other hand, all-electric or all-gas dwellings, whilst they may be energy efficient, would be penalized because consumption was confined to one source.

A further problem would be encountered with oil. This fuel is distributed by private enterprise and the form of charging is not subject to Government control.

47. The Committee believes that tariff structures should not be altered primarily to provide revenue for an insulation programme. It does, however, consider that tariffs could be more conservation-orientated. For example, consideration could be given to adopting a uniform domestic tariff where the rate would remain unaltered irrespective of the number of appliances or the amount of energy used.

If a uniform tariff was introduced which resulted in increased revenue for a supply authority, the Committee believes that the authority should use the additional revenue to assist the promotion of energy conservation.

48. Some problems may be encountered by households with large families. The energy consumed for essential needs could exceed the normal average household consumption and alterations to tariffs could disadvantage such families. This is regarded by the Committee as a social welfare problem and should be regarded as such by Government.

49. Any measures taken to conserve energy resources, especially oil and gas, are going to benefit the State and the community as well as the individual. Today's lifestyles, the business world and community activity depend so much on energy being readily available. Oil and gas reserves are limited. Production of oil from Bass Strait has reached its peak and is tending to decline. Whereas Bass Strait oil is today providing approximately 58 per cent. of Australia's oil requirements, (approximately 70 per cent. of petroleum requirements), it is expected that after 1985 this proportion will have decreased rapidly.

50. The Gas and Fuel Corporation advised that there is sufficient gas for domestic use at least until the year 2004 and probably until 2030. However, unless new gas discoveries are made, it advises that gas supplies for industry will be critical in the 1990's.

51. Mr. Wittwer of Broken Hill Proprietary Co. Limited stated that he could not see coal liquefaction being a practical venture by 1985, and that most people regarded liquefaction as a ten year prospect at best.

Before natural gas was discovered, gas was manufactured from coal. Victoria will have to return to this process in the future and new plants would need to be built for this purpose.

52. If there is to be no disruption to living standards and present lifestyles, a lead-time is necessary for new processes to be developed, the necessary plant to be built, and/or for additional discoveries of oil and gas to be made which will benefit Victoria and Australia. This " time-gap " can be assisted by reducing our present demands for energy and therefore making our known resources last longer.

53. As the State is basically responsible for providing energy services to the community, the Committee believes that energy conservation should be promoted by the State. It further believes that the State should provide financial assistance for an insulation programme. There are many demands on State finances and it may be necessary for part of the funds to come from sources other than the Consolidated Fund, e.g. energy supply authorities.

54. The Committee was advised that the New Zealand Government introduced an interest-free home insulation loan scheme in 1975 for a two-year period. Under this scheme, loans up to $150 for ceiling insulation and a further $150 for wall insulation could be obtained through the electricity or gas supply authorities. The loan was interest free and repayable over two years.

Nearly 29,000 houses (approximately the number of new houses built per annum in New Zealand) were insulated under this programme in the first year. Mr. Trethowen of the Building Research Association of New Zealand estimated, however, that approximately 90 per cent. of the funds went to older housing with only 10 per cent. going to new houses.

In the second year of the scheme, the loan limit for ceiling insulation was reduced to $85. It is believed that the scheme slowed down considerably after this reduction. However it is obvious that the New Zealand Government is convinced that the loan scheme has been worthwhile as it has reviewed the scheme after the first two years of operation and has restored the loan limits to their initial levels.

Mr. Trethowen estimated that there are as many houses being insulated outside the loan scheme as there are under the scheme, and that half those insulating under the scheme would have insulated in any case.

55. Other countries have used taxation incentives to implement insulation programmes. The Committee believes that, while tax incentives would be desirable in a total Australian context, for Victoria to achieve any measure of success in the near future, it must look at a scheme similar to that of New Zealand.

56. In order to calculate the approximate funds necessary for an insulation programme, the Committee sought quotations from several insulation companies for the average-sized house of 130 sq. m. (14 squares). To insulate the walls and ceiling during construction—walls with reflective foil laminate and ceilings with 75 mm. (3") of bulk insulation—the average cost was approximately $600. To install ceiling insulation alone would cost between $350 and $400 for 75 mm. of bulk insulation. No cost distinction was made between existing and new houses for ceiling insulation (bulk).

57. From estimates made by energy supply authorities and insulation manufacturers, the Committee estimates that approximately 800,000 existing dwellings have no insulation. This number could increase by approximately 20,000 per annum until insulation of new dwellings is made mandatory.

If this Committee's recommendations are adopted, there will be a basic core of 800,000 uninsulated dwellings. As mentioned earlier in this Report (see paragraphs 28 and 36) dwellings built before 1978 are going to account for the majority of energy consumed domestically over the next decade and it is not presently economically practicable to insulate the walls of dwellings after construction. The Committee believes that owners of existing dwellings should be strongly encouraged to insulate the ceilings and that loan amounts under the scheme should be biased towards ceiling insulation.

58. Accordingly, the Committee recommends that a scheme similar to that introduced by the New Zealand Government be started in Victoria with the maximum loan being $400 for wall and ceiling insulation. Loans should be limited to $300 for ceiling insulation only and to $100 for wall insulation only.

59. Earlier in this Report (paragraph 5) reference was made to the Housing Industry Association's opposition to mandatory insulation on the grounds that building costs would be increased and that many would-be home owners would be prevented from purchasing their own homes.

60. This aspect has been prominent in the Committee's considerations throughout the inquiry. Whilst its recommendations still leave the home owner ultimately paying the bill, the Committee believes that the initial lump sum payments for insulation can be greatly reduced by the proposed loan amount. Whether all or some of the balance of the insulation cost can be covered by the lending authorities by slightly higher loans will vary in each case depending on the authority's lending policy and the borrower's ability to repay the loan.

61. In the first year of the loan scheme, there will be approximately 30,000 new dwellings requiring full insulation at an estimated cost of $12 million. To make some provision for existing dwellings, the Committee believes that a minimum of a further $8 million would be necessary in the first year. This would enable approximately 26,500 existing dwellings to have ceiling insulation installed in the first year of the proposed scheme.

62. The Gas and Fuel Corporation of Victoria presently offers insulation to the community—not only gas consumers—through Gascor. The Corporation makes the funds available and repayments are made to the Corporation through the regular billing process or, in the case of non-gas consumers, special accounts are forwarded for the insulation repayment.

63. It appears to the Committee that the financing of a State-wide insulation programme would best be administered by the Gas and Fuel Corporation of Victoria and the State Electricity Commission of Victoria, preferably in a combined operation. As there are very few residences in Victoria which are not connected to either the gas or electricity supply, it should be possible for consumers to be billed for the insulation repayments with their gas or electricity accounts. Anyone not connected to either electricity or gas would still be eligible for the loan and could be billed in the same way as non-gas consumers are by Gascor at present.

64. The Committee was told that legislation makes it impossible for the State Electricity Commission to sell insulation and that an amendment to the *State Electricity Commission Act* 1958 would be necessary to permit the Commission to sell insulation. Should this interpretation of the Act prevent the Commission from financing and collecting insulation repayments under the scheme then the Committee recommends that the Act be amended so as to permit the Commission to operate in this area.

65. The initial insulation scheme should be for a period of five years. In each year a minimum of $20 million should be made available with a repayment period of five years. At the end of four years, the scheme should be re-assessed to see if it should be extended beyond five years. It will be necessary also to review the loan amounts annually in relation to costs.

66. The State Electricity Commission and the Gas and Fuel Corporation are both required by statute [*Public Authorities* (*Contributions*) *Act* 1966, s. 3 (1)] to pay a turnover tax of four per cent. to the Consolidated Fund. In addition, the State Electricity Commission pays a royalty of 2·46c per tonne of brown coal mined. It is interesting to note that in 1976–77 the Commission paid $18·72 m. turnover tax and $0·73 m. royalties—a total of $19·45 m.—whilst the Gas and Fuel Corporation paid $4·64 m. in turnover tax. The two State energy supply authorities combined paid a total of $24·09 m. into the Consolidated Fund—approximately the amount estimated by the Committee as being needed to fund the first year of an insulation programme.

67. The Committee recommends that—

(*a*) the Government, either alone or in conjunction with the State Electricity Commission and the Gas and Fuel Corporation, provide moneys to fund an insulation programme ;

(*b*) the State Electricity Commission and the Gas and Fuel Corporation together administer a fund to finance loans for the insulation of residential dwellings ;

(*c*) a maximum loan of $300 for ceiling and $100 for wall insulation be provided by the scheme ; and

(*d*) the loan amounts be reviewed annually in relation to costs.

STANDARDS OF INSULATION.

68. The conservation of energy in dwellings is a pressing priority and the Committee is convinced significant savings can be made by the introduction of mandatory levels of thermal insulation.

69. The C.S.I.R.O. stated that insulation standards should be expressed in thermal resistance terms rather than simply as thicknesses of bulk insulation. The statement of thermal resistance values allows the freedom to install various thicknesses of bulk insulation with different properties or reflective insulation materials whose performance is not related to thickness but to resistance to heat flow across air spaces. Thermal resistance expressed in the units (m^2K/W) is a measure of the resistance to heat flow of a material of any given thickness or a combination of materials. The higher the thermal resistance value the greater the insulating effect of the material or building element.

70. In order to measure the heat flowing from one side of a building element to the other i.e. inside to outside, the term " overall thermal resistance " is used. In this case the surface resistances on each side of the element are added to the thermal resistances of the components (e.g. bricks, mineral wool, plasterboard, air spaces), the total giving the overall thermal resistance.

The Australian Institute of Refrigeration, Air Conditioning and Heating (Inc.) has compiled a comprehensive list of typical thermal resistance values for common building materials or components (see Appendix C). Such a comprehensive list should simplify the calculation of overall thermal resistance values for the diverse number of construction elements found in use. The Committee believes that such lists should be readily available to persons engaged in the construction industry and interested members of the public.

71. To date the Committee has taken evidence regarding the thermal insulation of roofs and walls. The Committee realizes that there are many factors which determine the overall energy consumed in a building. In Victoria a significant amount of the total energy used in buildings (approximately 50 per cent.) is used for space heating. In individual cases, this is affected by many variables including the level of thermal insulation, amount of ventilation, the area and distribution of windows, the heating appliances, and the way occupants operate their dwellings. The last factor is most important. All structural improvements to the dwelling envelope may be neutralized by wasteful practices such as leaving doors and windows open. The Committee has already recommended a community education programme (see paragraph 10) which should cover the last aspect. As mentioned previously, these other factors will be considered more fully when the Committee inquires into " building designs, techniques and standards ".

72. The C.S.I.R.O. advised that the economic and scientific optimum thermal resistance for ceiling insulation in Victoria is $1 \cdot 4$ m^2K/W. The Gas and Fuel Corporation agrees with $1 \cdot 4$ m^2K/W. The Thermal Insulation Institute of Australia recommends a minimum thermal resistance of $1 \cdot 5$ m^2K/W for stud walls and 2 m^2K/W for roofs if substantial or continuous heating is required in winter.

73. Preliminary work carried out to date by the Standards Association of Australia indicates that a range of values from $1 \cdot 2$ to 2 m^2K/W would be suitable for thermal resistance of roofs for the Melbourne climate and depending upon the type of construction.

The values have been determined by considering a balance between the cost to the individual and the expected savings, and the community interest to conserve finite fossil fuel supplies. These values have also been calculated primarily on the basis of winter heating requirements for the Melbourne climate and they are minimum values only.

74. The Committee appreciates that extremes of climate may warrant slightly different values but for the sake of uniformity recommends a single set of values which correspond to Melbourne, the major population centre. In recommending a single set of values, it is anticipated that the levels recommended will also reduce energy requirements for summer cooling if cooling appliances are installed.

75. It is noted that the Standards Association of Australia is presently preparing a code of practice for the " Thermal Performance of Dwellings in Australia ". This document is not expected to be released until mid-1979. The Committee recommends that approaches be made to the Association requesting that work on this document be expedited.

Pending issue of final standards by the Association, the Committee recommends the adoption of minimum levels of thermal insulation.

76. For the purposes of its recommendations, the Committee defines roof and walls as follows :—

ROOF—the element separating the upper part of a dwelling from the exterior ; it includes the ceiling, roof cladding and roof space.

WALL—Two types of wall are distinguished.

Type I—which includes an external wall of a dwelling, or a wall between the dwelling and a freely ventilated space, or a wall or partition between a habitable room and a roof space.

Type II—wall or partition between a dwelling and any partially ventilated unheated space (e.g. attached garage, internal corridor), or common walls between adjoining dwellings.

77. The Committee recommends the following minimum values of overall thermal resistance for roofs and walls—

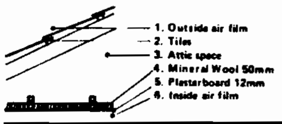
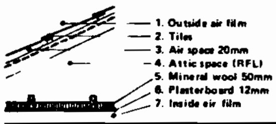
(*a*) For a dwelling with type I walls which have an overall thermal resistance less than $1 \cdot 4$ m^2K/W then the roof shall have a minimum overall thermal resistance of $1 \cdot 9$ m^2K/W when calculated for heat flow up (winter) situation ;

(*b*) For a dwelling with type I walls which have an overall thermal resistance equal to or greater than $1 \cdot 4$ m^2K/W, the roof shall have a minimum overall thermal resistance of $1 \cdot 5$ m^2K/W when calculated for heat flow up (winter) situation ; and

(*c*) All type II walls of a dwelling shall have a minimum overall thermal resistance of $0 \cdot 45$ m^2K/W.

78. The following diagrams show overall thermal resistance values for some typical forms of construction—

Typical Overall Thermal Resistances of Pitched Roofs

	THICKNESS OF BULK INSULATION (mm)	OVERALL THERMAL RESISTANCE (M^2K/W)	
		HEAT-FLOW -UP (Winter)	HEAT-FLOW -DOWN (Summer)
UNINSULATED	0	0.30	0.76
BULK INSULATION ON CEILING			
	25	0.90	1.36
	50	1.50	1.96
	75	2.10	2.56
	100	2.70	3.16
RFL ONLY	0	0.56	1.81
RFL SARKING AND BULK INSULATION			
	25	1.16	2.41
	50	1.76	3.01
	75	2.36	3.61
	100	2.96	4.21

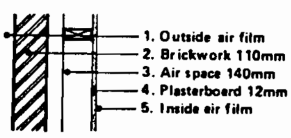
Notes:

1. The thermal resistance of the roof is based on terra cotta tiles, but it can be taken as typical of all types of roof material.

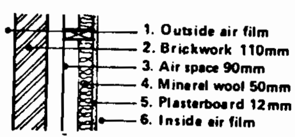
thermal resistance value of bulk insulation used in the examples is 0.6 m^2K/W for 25 mm thickness.

Typical Overall Thermal Resistances of Common Wall Constructions (Values are the same for heat-flow-in and heat-flow-out)

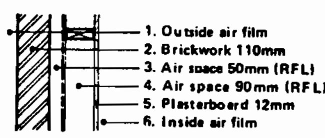
Brick Veneer



Uninsulated
R = 0.46

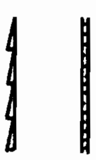


Insulated with 50 mm Batts
R = 1.70

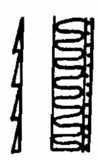


Insulated with RFL on outside of studs
R = 1.52

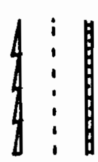
Weatherboard



Uninsulated
R = 0.50

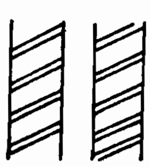


Insulated with 50 mm Batts
R = 1.66

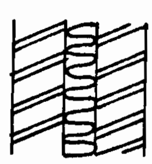


Insulated with RFL dished between studs
R = 1.56

Cavity Brick



Uninsulated
R = 0.53



Insulated with 50 mm Urea Formaldehyde
R = 1.88

79. Suitable combinations of roof and wall constructions complying with the recommended levels of insulation would be :—

Wall	*Roof*
Brick veneer wall insulated with reflective foil laminate (thermal resistance of element = 1.52 m^2K/W)	Tiled roof with 50 mm mineral wool insulation on ceiling (thermal resistance of element = 1.5 m^2K/W)
Brick cavity wall uninsulated (thermal resistance of element = 0.46 m^2K/W)	Tiled roof with 75 mm mineral wool insulation (thermal resistance of element = 2.10 m^2K/W)

80. Owners of existing dwellings and those building new dwellings should be encouraged to install insulation to a greater level than the required minimum in accordance with their budget, and for a given budget to distribute insulation in walls and the roof to gain the greatest benefit now and in the future.

81. Practically all forms of roof construction, if not already insulated to a suitable level, allow the addition of insulation at a reasonable cost. For several common wall constructions however, this is not the case. Once the wall is completed the cost of adding insulation cannot be justified on economic grounds and the possibility of future energy savings are reduced if the option is not initially taken up, For example, standard brick veneer and weatherboard walls are difficult to insulate after construction and much more expensive than if the insulation had been included at the time of building.

82. It is anticipated that the recommended education programme would highlight these points to enable the " optimum " distribution of insulation for a given expenditure.
The values recommended for overall thermal resistance of roofs and walls are not necessarily the " optimum " values but represent in the Committee's view reasonable minimum values.

83. To ensure the overall performance of the thermal insulation the products should be manufactured to rigorous specifications and installed in a manner to achieve their best effect (see SAA DR77139, Draft Code of Practice for the Installation of Bulk Thermal Insulation in Dwellings available from the Standards Association of Australia).

84. The SAA have already published standards for reflective foil laminate. These are—

AS 1903 " Specification for Reflective Foil Laminate ".

AS 1904 " Code of Recommended Practice for the Installation of Reflective Foil Laminate in Buildings ".

A series of standards for various bulk thermal insulation materials has also been prepared and have been issued as draft specifications for public review. The final documents are expected to be released by the end of this year.

The specifications produced so far are—

DR 77171 Mineral Wool Thermal Insulation—Batt and Blanket ;

DR 77172 Mineral Wool Thermal Insulation—Loose Fill ;

DR 77173 Cellulosic Fibre (Wood-Based) Thermal Insulation—Loose Fill ;

DR 77174 Sea Grass Bulk Thermal Insulation.

Specifications for some foamed plastics are in the course of preparation.

A series of test methods for thermal insulation has also been produced and released as a draft standard for public review. This is—

DR 77175 to 77180 Methods for Testing Thermal Insulation.

85. The Committee is concerned that insulation materials should not increase the fire hazard. The Metropolitan Fire Brigades Board advised the Committee that ' standards should be laid down that would limit the ignitability, spread of flame, and smoke produced characteristics of insulation materials.
This may well be achieved by quoting limiting indices for the above in accordance with Australian Standard 1530 Part 3 " Test for Early Fire Hazard Properties of Materials " '.

86. This standard requires testing ignitability, spread of flame, heat evolved, and smoke producing characteristics of the material. The Committee believes that only three of these are of concern when applied to insulation. They are ignitability, spread of flame, and smoke producing characteristics.

87. In the draft specifications listed above (see paragraph 84), the Standards Association refer to the fire tests which are required to be carried out on the insulating materials in accordance with AS 1530, Part 3. These are a production control test to give some degree of protection to the consumer regarding the fire hazard properties of the materials but do not relate to overall fire performance of the installed insulation.

The results of the tests are set out in the table below—

Material	*Ignitability* 0–20	*Spread of Flame* 0–10	*Heat Evolved* 0–10	*Smoke Developed* 0–10
Sea Grass	0	0	0	4
Mineral Wool (batt and blanket)	0	0	0	0
Mineral Wool (loose fill)	0	0	0	0
Cellulosic Fibre	—*	0	—*	no greater than 4

* No index was specified for cellulosic fibre as it was not considered to be indicative of the fire performance of the type of material. (See SAA DR 77173)

88. The lower the index the better the performance, but this is not to say that a material with indices of " 0 " for the first three tests and " 4 " for smoke developed is a fire hazard.

The Committee accepts that the insulating materials covered by the Association's present draft specifications (see paragraph 84) probably does not increase the fire hazard for normal constructions but would prefer strict limiting indices to be set.

89. Dr. G. Caird Ramsay of the Division of Building Research, C.S.I.R.O., Melbourne, in giving a lecture on " Thermal Insulation and Fire Tests " to the Thermal Insulation Institute of Australia in May, 1975, commented on the " Early Fire Hazard Test " by saying that " it was developed some twenty years ago following a series of simulated corner burn experiments and in this respect was way ahead of its time. In particular it was developed to assess wall boards with respect to ignitability, flame spread, heat evolved, and smoke produced, given a small fire such as burning furniture. Since its development, the test has been applied to many materials and systems other than those examined in the original corner burns. In fact various insulation materials have been subjected to the test procedure and indices reported. However, several points should be noted—

(*a*) The test was devised for cellulosic wall boards and did not take into account plastics materials such as cellular plastics.

(*b*) Insulation materials are generally used as part of an element as was discussed previously and the performance of the element may bear little relation to results obtained on the insulation alone. This is especially true where the insulation is not exposed.

(*c*) The specimen is tested in a vertical plane but elements containing insulation are often used in a horizontal rather than a vertical orientation ." (6).

90. In view of these comments, the Committee believes that research should be carried out which would permit a comprehensive fire test and standard to be devised for all types of insulating materials.

GENERAL

91. In its Report, dated 5th May, 1977, the Committee made several recommendations on conservation of energy generally. These related to—(i) the heating of swimming pools ; (ii) education of the community ; and (iii) the need for Government departments and employees to set an example.

Swimming Pools

92. The Committee made its recommendations for banning the use of oil and natural gas for heating domestic swimming pools in the belief that this was an extravagant use of finite energy resources. Since making those recommendations the Committee has been advised that many complaints and queries from pool owners and potential pool owners have been received by the Department of Minerals and Energy, the Gas and Fuel Corporation and swimming pool builders. Some complaints also reached the Committee directly.

(6) Thermal Insulation, Vol. 1, No. 4, August, 1976.

Whilst most of the complaints indicated a misunderstanding of the Committee's recommendations, the main thrust seemed to be that swimming pool heaters do not consume a large proportion of the total energy used and that a number of pools are heated for therapeutic purposes.

93. No figures were available for either the amount of gas or oil consumed in domestic pool heating, or the number of pools required for therapeutic purposes.

It is estimated by the Gas and Fuel Corporation that the consumption of gas for domestic swimming pool heating would have amounted to less than one half of one per cent. of the total gas used in 1976–77. A manufacturer of swimming pool heaters estimated that "possibly as many as 30 per cent. of pools with heaters have had the heaters installed because of some medical or physical problem". However, no statistics are available to support or deny either estimate. The figure of 30 per cent. estimated for therapeutic purposes seems high to the Committee.

94. Irrespective of the actual figures for gas consumption and heated pools for therapeutic purposes, the Committee is still firmly of the opinion that the use of oil or gas for heating domestic swimming pools is extravagant.

95. Manufacturers of gas pool heaters and the Gas and Fuel Corporation stated that the average life expectancy of pool heaters is eight to ten years. In view of the fact that consumers have purchased pool heaters with the expectation of being able to use them and manufacturers have placed orders in advance for heaters and components, the Committee has reconsidered its earlier recommendations.

96. To avoid any immediate financial hardship or commercial uncertainty, the Committee believes that the lead time for the selling of heaters should be extended until 1980. The use of oil and gas for heating domestic swimming pools should be completely phased out by 1990. This is about the time that natural gas supplies for industry are expected to be critical unless new discoveries of natural gas are made.

97. Representatives of the swimming pool industry stated that heat loss from uncovered pools is considerable. Figures of up to $500 per quarter were quoted for heating pools by gas in winter. It was claimed that pools can lose 38 mm to 50 mm (1½″ to 2″) of water in a week through evaporation. This evaporation, a major source of heat loss, can be reduced by 80 per cent. with the use of pool covers with a resultant 40 per cent. savings in fuel costs according to manufacturers of pool heaters. Properly designed pool covers have been credited with savings of up to 50 per cent. in heating bills. It was stressed that these covers were not safety covers but purely energy savers.

98. If a cover could be designed which would improve the thermal performance of the pool and at the same time provide a measure of safety, then gains would have been made in two very important areas.

99. The Committee recommends that—

(*a*) the installation of oil and gas heaters for domestic swimming pools be prohibited after 31st December, 1980;

(*b*) all domestic swimming pool owners be prohibited from using oil or gas for heating after 31st December, 1990; and

(*c*) the use of thermal pool covers be encouraged by energy supply authorities.

Community Education

100. The Committee is of the opinion that the success of any measures taken to conserve energy will be influenced by community response to these measures. Most witnesses appearing before the Committee said that they were aware of the need to conserve energy. Several witnesses did admit, however, that either they or the organizations they represented had not previously considered the question of energy conservation.

101. The community is becoming aware of the need to conserve energy. If conservation measures are going to be implemented in the future, some of which will impose a financial burden on the community, then the Committee believes that information must be given to the public which will help it to accept conservation measures. The community must be shown that the benefits of energy conservation measures will more than justify initial capital costs. These measures will be adopted more successfully if the community understands the reasons for their implementation.

102. Canada and the United Kingdom are both very active in energy conservation programmes. The respective departments administering the conservation programmes freely distribute material for the benefit of the public. In its earlier Report, the Committee recommended that the Department of Minerals and Energy should assume this responsibility in Victoria.

The Committee now believes that a separate Office of Energy Conservation should be established within the Department. This office should be the prime authority for the promotion of energy conservation by Government departments and instrumentalities. It should also be responsible for the preparation and distribution of conservation material to the public and schools. Using Canada as an example, an education programme should have two goals—

(*a*) to educate the public and explain why conservation measures are necessary ; and

(*b*) to educate children to be energy conscious.

103. A sample of the type of material distributed by the Office of Energy Conservation, Department of Energy, Mines and Resources, Canada, and the U.K. Department of Energy, is appended (Appendix D) to this Report.

Government Example

104. Members of the public cannot be expected to accept conservation measures unless Government departments and State instrumentalities set an example.

105. In its earlier Report, the Committee mentioned three areas where some action could be taken immediately. There does not appear to have been any general direction or action to date in these areas within the Public Service generally.

The three areas mentioned were—

(*a*) only light at night the section of a building that is actually being cleaned or used, not whole floors ;

(*b*) only heat or light rooms when in use ; and

(*c*) thermostats controlling heating and air conditioning should be set at 20° C.

The Committee believes that many multi-storey office blocks are illuminated unnecessarily at night. It also believes that lights and, in winter, heaters in many offices are switched on as a matter of course irrespective of whether or not they are actually needed.

106. Very little action is required in these areas to achieve some success. With the exception of security lighting, any switching off of lights would be readily apparent to the public and could induce owners or occupiers of other multi-office buildings to follow suit.

107. In June, 1977, it was announced by the Premier that he had fixed a target of 25 per cent. of four-cylinder cars for all Government departments by June, 1978. On 23rd April, 1978, the Premier announced that the target had already been met and that of the total 3,848 Government (not including State instrumentalities') cars, station wagons, panel vans and utilities (excluding police vehicles), already 1,202 (31 per cent.) are four-cylinder vehicles. He also announced that the target will be set even higher in the forthcoming year and, although no figures were given, said that the savings in energy use and cost are already clearly evident.

108. The Committee believes that the Government, State instrumentalities and municipalities throughout Victoria should purchase four-cylinder vehicles where feasible. Such a move should result in considerable financial savings as well as savings in energy consumption.

109. During the energy crisis in the United States of America, a maximum speed limit of 55 m.p.h. (90 k.p.h.) was introduced as a means of reducing fuel consumption. Canada recommends the same speed and in fact the Office of Energy Conservation of Canada distributes car stickers recommending " 55 max. for better mileage " (see Appendix D).

It seems to be conceded by experts in the motor industry that, irrespective of the make or model of car, 90 k.p.h. (55 m.p.h.) is the maximum speed for efficient fuel consumption. Once vehicles exceed 90 k.p.h. the rate of fuel consumption increases rapidly.

110. From an energy conservation point of view, the Committee would like the maximum speed limit reduced to 90 k.p.h. It realizes, however, that there are many aspects which must be considered in relation to speed limits. Whilst the Committee makes no recommendation on reducing speed limits, it does recommend that education programmes include this aspect and that the community be encouraged to voluntarily adopt a 90 k.p.h. speed limit.

111. In November, 1977, the Victorian Parliament passed the *Transport Regulation (Amendment) Act* 1977 which was subsequently proclaimed to operate from 25th January, 1978.

One of the amendments made by this Act legalizes car sharing—a system whereby people get together and share their vehicles. The aim of car sharing is to reduce the number of vehicles travelling at peak period to particular points, especially the central business district. Car sharing and pooling has been mentioned to the Committee on several occasions and will be considered during its inquiry into transport systems which will commence immediately. The Committee will watch, with interest, any reaction by the community to car sharing.

State and Commonwealth Government Co-operation

112. The Committee supports the National Energy Advisory Committee's recommendation for energy conservation programmes to be implemented by each State and for the Minister for National Resources and the relevant State Minister to co-operate with each other in the implementation of their programmes and in the conservation of energy generally. The Committee believes that with Commonwealth Government support and encouragement, possibly by taxation incentives, some energy conservation programmes could be promoted quite successfully on a national basis.

113. In April, the Government announced that it would soon have an updated Energy Policy based on the 1977 " Green Paper " and that the policy will be open for public comment. The Committee supports this action and believes that any energy policy must be kept continually under review to take account of the continually changing energy scene.

114. United Kingdom authorities believe that an expenditure of 320 million pounds over a four-year period will result in energy savings of about 700 million pounds a year. The Committee believes that energy conservation is initially going to cost the Government money. Education programmes must support any compulsion or inducement to save energy.

As mentioned earlier in this Report, it is estimated that at least $20 million per annum would be needed to finance an insulation programme. If conservation measures are to be successful, the Committee believes that a budget in excess of $20 million should be made for energy conservation in 1978–79—$20 million for insulation and an additional amount for education programmes for the community and a special campaign aimed at school children.

Committee Room,

10th May, 1978.

EXTRACT FROM THE PROCEEDINGS

The following extract from the Minutes of the Proceedings of the Committee shows a Division which took place during the consideration of the Draft Report—

WEDNESDAY, 10TH MAY, 1978.

Paragraph 40*

The Committee recommends that—

(*a*) ceiling and external wall insulation be mandatory for all future dwellings ; and

(*b*) ceiling insulation be strongly encouraged for dwellings erected prior to insulation being made mandatory.

Amendment proposed—That all the words and expressions after " that " be omitted with a view of inserting in place thereof the words " the insulation of walls and ceilings of all future dwellings and ceiling insulation of existing dwellings be strongly encouraged ".

(*Mr. Evans*)

Question—That the words and expressions proposed to be omitted stand part of the paragraph—put.

The Committee divided.

Ayes, 6.	Noes, 1.
Mr. Amos	Mr. Evans
Mr. Cathie	
The Hon. V. T. Hauser	
Mr. McClure	
Mr. Plowman	
The Hon. I. B. Trayling	

And so it was resolved in the affirmative—Amendment negatived.

*Paragraph 40 subsequently renumbered and appears as paragraph 37 in this Report.

APPENDIX A

List of Witnesses

Mr. J. Mendleson, Senior Engineer, Ministry of Fuel and Power

Mr. L. Sims and
Mr. A. Croker
representing The Master Builders Association of Victoria

Mr. P. J. Mellett, Product Manager, A.C.I. Fibreglass
Mr. S. Stanford, Marketing Manager, Bradford Insulation Industries Pty. Ltd.
Mr. G. G. Chaplin, Marketing Manager, A.C.I. Fibreglass and
Mr. R. Hill, Consultant, International Public Relations Pty. Ltd.
representing the Fibreglass Insulation Manufacturers' Association of Australia

Mr. R. G. Chapman, Assistant General Manager (Marketing and Distribution), State Electricity Commission of Victoria

Mr. T. D. Vaughan, Commissioner, Housing Commission of Victoria

Mr. J. Baird, Architect
Mr. R. Ramus, Architect, and
Mr. A. Coldicutt, Engineer
representing the Royal Australian Institute of Architects, Victorian Chapter

Mr. M. K. Pinnock, Manager, Victoria, Housing Industry Association

Mr. D. Tribe, Manager, Research and Development Division, Housing and Land Group, Jennings Industries Limited

Mr. M. R. Brown, Treasurer, and
Mr. A. M. Brown, Junior Vice-President)
representing the Australian Institute of Refrigeration, Air-Conditioning and Heating (Inc.) Victoria Division

Mr. W. T. Feagan, Vice President,
Mr. A. Coldicutt, Engineer and
Miss D. White, Convenor, Technical Committee
representing the Thermal Insulation Institute of Australia

Mr. E. R. Ballantyne, Officer-in-Charge, Architectural Physics Section, Division of Building Research,
Mr. L. F. O'Brien, Architectural Physics Section, Division of Building Research, and
Mr. M. J. Wooldridge, Leader, Human Environment Engineering Group, Division of Mechanical Engineering
representing the Commonwealth Scientific and Industrial Research Organization

Mr. H. H. Batt, Technical Director, Renhurst Industries Pty. Ltd. and
Mr. F. R. Richards, Technical Consultant (Building), St. Regis-A.C.I. Pty. Ltd.
manufacturers of reflective foil laminate

Mr. C. A. Kneipp, Executive Director and
Mr. D. P. McNally, Manager, Production Development and Technical Services, Comalco Limited
representing the Aluminium Development Council

Mr. D. Turner, Assistant Chief Engineer (Mechanical), Building Division, Public Works Department

Mr. J. M. Shaw, Assistant General Manager and Associate Director, and
Mr. K. J. Doyle, Marketing Manager
representing the Gas and Fuel Corporation of Victoria

Mr. F. Tromp, Air Quality Officer, and
Mr. G. I. Milgate, Head Quality Officer
representing the Environment Protection Authority, Ministry for Conservation

Mr. B. Gangell, Director and Victorian Branch Manager, Environ Mechanical Services Pty. Ltd.

Mr. D. A. Wittwer, General Manager, Oil and Gas Division, and
Mr. W. H. Sweetland, Co-ordinator Planning, Oil and Gas Division
representing Broken Hill Proprietory Co. Limited

Mr. A. Tomkin, Managing Director, Tomkin Homes (Aust.) Pty. Ltd.

Mr. A. S. Miller, Lawyer and Fulbright Scholar, Macquarie University

Mr. H. Trethowen, Building Research Association of New Zealand

Mr. N. A. Smith, Chairman and General Manager,
Mr. K. J. Doyle, Marketing Manager
representing the Gas and Fuel Corporation of Victoria

Mr. D. J. McKenzie, Managing Director, Solarlite Heating Systems Pty. Ltd.

Mr. P. C. Brown, Professional Engineer

Mr. W. R. Feagan, Manager, Insulwool Division, Australian Gypsum Ltd.
Mr. G. G. Chaplin, Chairman, Energy Management Committee
Mr. S. Stanford, Marketing Manager, Bradford Insulation Industries Pty. Ltd.
representing the Fibreglass Insulation Manufacturers' Association of Australia

Mr. D. Schintler, Marketing Development Manager, and Acting Assistant General Manager (Marketing and Distribution), State Electricity Commission of Victoria.

Mr. D. Worledge, and
Mr. K. Ellis
representing the Gas Appliance Manufacturers Association of Australia (Victorian Division)

Mr. G. Drakeford, and
Mr. F. A. Arblaster
representing the Oil Burning Industry Association.

Mr. A. G. V. Law, President, and
Mr. B. E. Wallace, Administrative Director
representing the Swimming Pool Association of Victoria
and
Mr. N. R. Pearce, National President, Council of Australasian Swimming Pool Associations

Mr. D. Lin, Senior Research Architect, Local Government Department

Dr. J. E. H. Milne, Deputy Chief Industrial Hygiene Officer, Industrial Hygiene Division, Department of Health

APPENDIX B

List of Submissions

Domestic Thermal Insulation in Victoria with an Appendix
Additional Information on Home Insulation
} forwarded by Fibreglass Insulation Manufacturers' Association of Australia.

Energy Policy in Victoria—Conservation of Energy in Buildings—Thermal Insulation Institute of Australia.

Insulation (including heating and cooling) of buildings—Divisions of Building Research and Mechanical Engineering, C.S.I.R.O.

Use of Insulation in Buildings—Reflective Foil Laminate Manufacturers.

Energy Utilization and Conservation—Aluminium Development Council.

Energy Use, Energy Conservation and Insulation Practices in the Design and Construction of Government Buildings—Public Works Department of Victoria.

Use of Insulation in Buildings—Gas and Fuel Corporation of Victoria.

Use of Insulation in Buildings—Environment Protection Authority.

Insulation of Residential Dwellings—The Housing Industry Association (Victorian Division).

Swimming Pool Heating—Gas Appliance Manufacturers Association of Australia (Victorian Division).

Heating of Swimming Pools—The Swimming Pool Association of Victoria.

Financing a Compulsory Home Insulation Programme—Miss D. White, B.Arch.

APPENDIX C

An extract from the Australian Institute of Refrigeration, Air Conditioning and Heating (Inc.) Design Data Manual.

THERMAL PROPERTIES OF BUILDING AND INSULATING MATERIALS

Material	Density, ρ (kg/m³)	Thickness, d (mm)	Temp. (°C)	Moisture Content (%)	Thermal Resistance: Thermal Conductivity, k (W/m.K)	Thermal Resistance: Thermal Resistance for Listed Thickness, R (m².K/W)	Thermal Capacity: Specific Heat Capacity, c (J/kg.K)	Thermal Capacity: Heat Capacitance for listed Thickness, C (kJ/m².K)
Air	1.2		27	0	0.026		1012	
Aluminium	2680	1.2	0		210	5.7x10⁻⁶	880	3
Asbestos								
brick	400	90	500		0.094	0.96	840	30
cement board	945	6	33	0	0.19	0.032	840	5
cement sheet - ('fibro cement')	1490	6	29	0	0.32	0.019	840	8
" "	2000	6			0.43-0.65	0.014-0.009	840	10
felt,1 lamination per mm	320	10	38		0.079	.13		
felt,2 lamination per mm	480	10	38		0.058	0.17		
fibre, loose	59		23	0	0.042			
" "	29		23	0	0.046			
millboard	720	22		0	0.11	0.20	820	13
"	1040	22	66,24		0.20	0.11	820	19
Asphalt (bitumen containing mineral matter)	2250				1.22		1700	
Bark Fibre								
eucalypt	54		0		0.050		1700	
redwood	48		32		0.045			
"	80		32		0.040			
Bitumen	1060				0.16			
composition for floors	960		14		0.16		1470	
" "	2400		26		0.99		1470	
emulsion,cement, aggreg.	1600				0.46			
" "	2000				0.61			
roofing membrane	1120	10	24		0.16	0.061		2
Brick								
common	1760	90		0	0.81	0.11	920	146
"	1870	90		6	1.21	0.074	920	155
"	1920	90		9	1.43	0.063	920	159
"	1970	90		12	1.47	0.061	920	163
"	2030	90		16	1.67	0.054	920	169
red	1760	110			0.65	0.17	920	179
sand-lime	1840	110		0	1.08	0.16	840	170
" "	1920	110		5	1.59	0.069	840	177
silica	740-1040		499		0.030-0.50			
"	2240	90	38		0.89	0.10		
"	2240	90	93		0.94	0.096		
"	2240	90	315		1.10	0.082		
"	2240	90	540		1.27	0.071		
"	2240	90	1370		1.90	0.047		
Brickwork, (fired clay brick wall)		90		3	1.15	0.078		147
Carpet Underlay		15			0.039-0.062	0.41-0.24		

\# Where two values are given in the temperature column, separated by a comma, the first refers to the hot face and the second to the cold face temperature.

APPENDIX C (*continued*)—

Material	Density, ρ (kg/m³)	Thickness, d (mm)	Temp. (°C)	Moisture Content (%)	Thermal Resistance: Thermal Conductivity, k (W/m.K)	Thermal Resistance: Thermal Resistance for Listed Thickness, R (m².K/W)	Thermal Capacity: Specific Heat Capacity, c (J/kg.K)	Thermal Capacity: Heat Capacitance for Listed Thickness, C (kJ/m².K)
Cellulose Fibre								
fireproofed	42		21	0	0.039			
"	83		20		0.047			
Chaff, fireproofed	130		12		0.052			
Charcoal	184		-4	0	0.051		840	
from maple, beech and birch	210		32		0.052			
Coconut Fibre husk	48		32		0.053			
Concrete								
cellular	320	100			0.084	1.19	960	31
"	480*	100			0.11	0.93	960	46
"	640*	100			0.14	0.69	960	62
"	800*	100			0.20	0.50	960	77
"	960*	100			0.26	0.38	1050	101
"	1280*	100			0.43	0.23	1050	134
"	1600*	100			0.65	0.15	1050	170
clinker aggregate 1 : 2½ : 7	1520*	100		7	0.33	0.30	75	115
clinker aggregate, 1 : 2 : 4	1680*	100		4	0.40	0.25	75	125
clinker aggregate, 1 : 3½ : 6	1730*	100			0.76	0.13	75	130
coke breeze	1760	100	24		0.75	0.13		
crushed rock, 1 : 2 : 4	2400*	100			1.44	0.069	880	210
expanded clay agg.	800	100		5	0.29	0.35		
" " "	960	100		5	0.30	0.33		
" " "	1120	100		5	0.35	0.29		
" " "	1280	100		5	0.48	0.21		
gravel, 1 : 1 : 2	2340	100	30		0.94	0.11	800	190
scoria	1900	100		0	0.69	0.15	837	150
vermiculite, 1 : 3	2340	100			0.43	0.23		
" 1 : 2 : 4	770	100			0.27	0.36		
" 1 : 3 : 6	580	100			0.19	0.53		
Copper, sheet	8790	1.2			385	3.12×10^{-3}	400	4
Cork								
board	144	22	7	0	0.042	0.53	1800	6
granulated, baked	104*			5	0.039	-	1760	
" "	104		32,24	0	0.045		1760	
granulated, raw	117			7	0.046		1760	
slab, baked (density, variation)	112*	12		3-5	0.039	0.31	1760	2
" "	128	12			0.040	0.30	1800	3
" "	144	12			0.042	0.29	1800	3
" "	160	12			0.045	0.29	1800	4
" "	128	12	16,-73		0.033	0.36	1800	3
" "	128	12	16,-18		0.038	0.32	1800	3
" "	128	12	16,-1		0.039	0.31	1800	3
" "	128	12	66,1		0.043	0.28	1800	3
" "	128	12	93,1		0.047	0.26	1800	3
slab, baked (high density)	264*	12			0.049	0.25		
raw	160			7	0.049			
raw, high density	465				0.079			
with asphalt or bitumen binder	240				0.055			
" "	640				0.14			
" "	1040				0.29			

* Specimens have been conditioned in an atmosphere at 18°C and 65% relative humidity.

APPENDIX C (*continued*)—

Material	Density, ρ (kg/m³)	Thickness, d (mm)	Temp. (°C)	Moisture Content (%)	Thermal Resistance: Thermal Conductivity, k (W/m.K)	Thermal Resistance: Thermal Resistance for Listed Thickness, R (m².K/W)	Thermal Capacity: Specific Heat Capacity, c (J/kg.K)	Thermal Capacity: Heat Capacitance for Listed Thickness, C (kJ/m².K)
Cork (continued)								
with cement binder	280				0.072			
" " "	400				0.10			
" rubber latex binder	320				0.062			
" " " "	800				0.13			
Eel Grass								
(Zostera marina)	21		24	0	0.046			
" "	55		24	0	0.037			
Felt								
hair	80				0.039		1380	
lightweight car body lining felt	32				0.039			
undercarpet felt	120				0.046			
wool	136-168				0.039			
Fibreboard (see Wood Products)								
Fibrous Plaster (see Gypsum)								
Fireclay								
brick	620	115	499		0.20	0.59		
"	960	115	499		0.34	0.34		
"	1230	115	499		0.48	0.24		
"	1930	115	260		0.96	0.12	840	186
"	1930	115	816		1.18	0.10	840	186
Glass								
cellular slab	140	50	10		0.055	0.91		
cloth, woven	140		24		0.058			
" "	480				0.058			
" "	800				0.087			
float, window, clear & tinted	2510	6			1.05	0.006	840	14
Glass Fibre								
batts	12	50	20		0.043	1.16	880	1
	22	50	20		0.035	1.43	880	1
	24	50	20		0.034	1.47	880	1
	30	50	20		0.034	1.47	880	1
	48	50	20		0.033	1.52	880	2
	56	50	20		0.033	1.52	880	2
	64	50	20		0.032	1.56	880	3
	80	50	20		0.040	1.25	880	4
loose fill	12		20		0.049		880	
Granite	2650				2.9		900	
'Gyprock Wallboard' (Aerated gypsum core between rough millboard)	850	25			0.16	0.16		
Gypsum								
fibrous plaster	1105	9	17	0	0.27	0.033		
foamed plaster	300		-0.6	0	0.059			
" "	300		41	0	0.064			
plaster	1220	15	15	0	0.37	0.041	1090	20
gypsum board	880	10	23	0	0.17	0.059	1050	9
" "	880	13			0.17	0.077	1050	12
" "	880	16			0.17	0.094	1050	15
powder	320				0.065		1080	

APPENDIX C (*continued*)—

Material	Density, ρ (kg/m³)	Thickness, d (mm)	Temp. (°C)	Moisture Content (%)	Thermal Resistance: Thermal Conductivity, k (W/m.k)	Thermal Resistance: Thermal Resistance for Listed Thickness, R (m².K/W)	Thermal Capacity: Specific Heat Capacity, c (J/kg.K)	Thermal Capacity: Heat Capacitance for Listed Thickness, C (kJ/m².K)
Hardboard (steam exploded wood, 'Masonite').	1025	4.5			0.22	0.020	1675	8
Ice	926		-46		2.7		2110	
"	921		-18		2.5		2110	
"	918		-1		2.2		2110	
Jute, fibre	37		32		0.029			
"	56		32		0.036			
"	140		32		0.039			
"	200		32		0.042			
Lead, sheet	11400	1.8			34.6	$5.2x10^{5}$	126	3
Linoleum, inlaid	1300	3	16		0.22	0.014	840	3
Marble								
various samples	2640-2800				1.3-1.7		880	
Mica, brick		25	499		0.16			
Mortar								
cement, sand, 1 : 3	1890	15		0	0.88	0.017	795	25
" " "	2000	15		6	1.12	0.013	795	26
" " "	2080	15		10	1.30	0.012	795	27
" " 1 : 4	1950	15		0	0.93	0.016	795	26
" " "	2000	15		2.5	1.1	0.014	795	26
Paints								
aluminium					0.46			
anti-condensation	800				0.16			
varnish					0.32			
zinc-filled paints	4645				2.2			
Paper	1090	0.2			0.14	0.001	1340	
kraft building paper		0.2			0.065	0.003		
Particle Board (see Wood Products)								
Perlite (see also Plaster)								
loose, expanded granules	65		38,4	0	0.046			
" " "	65		204,4	0	0.085			
cement, sprayed	350				0.08			
" "	420				0.11			
Phenolic Foam	32				0.038			
Plaster (see also Gypsum)								
foamed	400				0.10			
"	640				0.16			
"	880				0.24			
vermiculite	640	15			0.20	0.074		
"	960	15			0.30	0.050		
lime, cement	1440	15			0.48	0.032	880	19
lime, sand 1 : 1		15	29		0.48	0.032	880	19
cement, sand 1 : 4	1570	15	29		0.53	0.028	880	19
gypsum plaster, sand	1410	15			0.65	0.023		
gypsum plaster, perlite	615	15			0.12	0.13		

Appendix C (*continued*)—

Material	Density, ρ	Thickness, d	Temp.	Moisture Content	Thermal Resistance		Thermal Capacity	
					Thermal Conductivity, k	Thermal Resistance for Listed Thickness, R	Specific Heat Capacity, c	Heat Capacitance for Listed Thickness, C
	(kg/m³)	(mm)	(°C)	(%)	(W/m.K)	(m².K/W)	(J/kg.K)	(kJ/m².K)
Plywood								
plywood	530	5		12	0.14	0.036		
fire proofed	560	5		12	0.15	0.033		
Polystyrene								
expanded	16	50	38		0.039	1.28	340	
"	16	50	10		0.035	1.43	340	
"	16	50	0		0.032	1.56	340	
"	16	50	-18		0.030	1.67	340	
"	16	50	-33		0.027	1.85	340	
"	16	50	-40		0.026	1.92	340	
"	16	50	-88		0.020	2.50	340	
Polyurethane								
rigid, foamed, new	24	50			0.016	3.13	450	
rigid, foamed, aged	24	50			0.025	2.00	450	
flexible, foamed	40	50			0.035-0.039	1.43-1.28	450	
Porcelain (electrical grade)	2400				1.44		920	
Rock Wool								
batts	32	75	1	0	0.032	2.34	920	2
"	32	75	14	0	0.033	2.27	920	2
"	32-48	75	23	0	0.035	2.14	920	2-3
"	104	75	59	0	0.035	2.14	920	7
"	112-144	50	20		0.034	1.47	920	5-7
"	176	50	20		0.035	1.43	920	8
loose fill	80		23	0	0.040			
"	64		-18		0.036			
"	64		21		0.040			
"	64		38		0.043			
"	160		-18		0.032			
"	160		-21		0.035			
"	160		38		0.037			
Rubber								
cellular slabs	80	50			0.040	1.25	1670	7
" "	160	50			0.043	1.16	1670	13
" "	240	50			0.055	0.91	1670	20
" "	400	50			0.084	0.60	1670	33
sheet (India)	930	4			0.16	0.025	2010	745
synthetic	960	4			0.16	0.025		
Sand								
building	1500			0	0.30		800	
fine silver	1600		21	0	0.32			
" "	1600		160	0	0.36			
" "	1600		265	0	0.37			
Sandstone	2000				1.30		920	
Sawdust	200		30		0.059			
bonded with urea formaldehyde	440			0	0.10			
resin soaked	825			30	0.39			
bonded with Portland cement 1 : 2	1200				0.29-0.35			
" 1 : 4	660				0.17-0.20			
Portland cement, sand, sawdust 1 : 1½ : 1½ (see also Magnesium Oxychloride)	1600				0.58-0.72			

APPENDIX C (*continued*)—

Material	Density, ρ	Thickness, d	Temp.	Moisture Content	Thermal Resistance: Thermal Conductivity, k	Thermal Resistance: Thermal Resistance for Listed Thickness, R	Thermal Capacity: Specific Heat Capacity, c	Thermal Capacity: Heat Capacitance for Listed Thickness, C
	(kg/m^3)	(mm)	(^{o}C)	(%)	(W/m.K)	(m^2.K/W)	(J/kg.K)	(kJ/m^2.K)
Shavings (see Wood Products)								
Silica Brick	740-1040		499		0.30-0.50			
" "	2240	90	38		0.89	0.10		
" "	2240	90	93		0.94	0.96		
" "	2240	90	315		1.10	0.082		
" "	2240	90	540		1.27	0.071		
" "	2240	90	1370		1.90	0.047		
Sisal Fibre	110		32		0.039			
Slate	2950		120		1.53		750	
"	2650		94		1.50		750	
expanded	880				0.25			
Soil								
clay soil, from depth 1.5m			21		1.08			
" " " 3 m			21		1.08			
" " " 6 m			21		1.17			
" " " 8 m			21		1.25			
" " loosely pack.	1200		20	14	0.37			
" " loaded 5kPa	1280		20	14	0.71		1170	
" " " 107kPa	1540		20	14	1.21		1260	
Steel								
mild	7850	6			47.5	1.26x10^{-4}	500	24
wool, very fine	48		32		0.071			
" " "	78		32		0.074			
" " "	109		32		0.075			
Stoneware	2160				1.45		870	
Straw								
board	256				0.087			
compressed, faced with paper	320	50	16	0	0.081	0.62	1050	17
fibres, pressed	220		32		0.071			
slabs of compressed wheat straw, wired	213	50			0.041	1.24		
wheat, uncrushed	74	0	32		0.043			
Sugar Cane								
fibre	64	32			0.040			
"	96		32		0.042			
"	128		32		0.045			
"	160		32		0.051			
"	19		32		0.053			
"	225		32		0.056			
fibreboard	215		23		0.062			
"	215		21		0.048			
Terrazzo	2440				1.6			
Tiles, clay, roofing	1922	19			0.84	0.023	921	34

APPENDIX C (*continued*)—

Material	Density, ρ (kg/m³)	Thickness d (mm)	Temp. (°C)	Moisture Content (%)	Thermal Resistance: Thermal Conductivity, k (W/m.K)	Thermal Resistance: Thermal Resistance for Listed Thickness, R (m².K/W)	Thermal Capacity: Specific Heat Capacity, c (J/kg.K)	Thermal Capacity: Heat Capacitance for Listed Thickness, C (kJ/m².K)
Timber *								
across grain:								
Alpine ash	688	25		12	0.16	0.16	2090	36
Blackbutt	885	25		12	0.20	0.13	2090	46
Jarrah	862	25		12	0.20	0.13	2090	45
Karri	910	25		12	0.21	0.12	2090	48
Mountain ash	677	25		12	0.16	0.16	2090	35
Oregon	544	25		12	0.11	0.23	2090	28
Pine, radiata	506	25		12	0.10	0.25	2090	26
Rose gum	803	25		12	0.19	0.13	2090	42
Stringy bark (Messmate)	712	25		12	0.14	0.18	2090	37
Urea Formaldehyde Foam	8			0	0.038			
"	12			0	0.036			
"	15			0	0.032			
"	30			0	0.032			
Vermiculite								
exfoliated	128		38		0.069			
"	270		38		0.082			
"	270		165		0.099			
"	270		260		0.11			
expanded	112-130		-1		0.063			
"	112-130		32		0.069			
loose granules	80-112				0.065			
Vinyl (Floor tiles)	2050	2			0.79	0.003	840	3
Vinyl-Asbestos								
semi-flexible floor covering	1970	3	15		0.50	0.006		
Water	1000	10	20		0.60	0.017	4190	42
"	980		60		0.65			
Wood Products								
Fibreboard	220	12		10-12	0.052	0.23		
"	380	12		10-12	0.064	0.19		
" (Caneite)	260	12			0.052	0.23	1507	5
"	290	12		10	0.056	0.21		
"	340	12		30	0.075	0.16		
fireproofed	290	12		8	0.058	0.21		
fibre & pulp boards	240	18	28		0.055	0.33	1420	6
" " "	320	18	29		0.059	0.30	1420	8
" " "	48	18	32		0.043	0.42	1420	1
" " "	80	18	32		0.043	0.42	1420	2
" " "	106	18	32		0.045	0.40	1420	3
" " "	140	18	32		0.046	0.39	1420	4
particle board (wood chips bonded with resin)	480	18			0.108	0.17		
" " "	640	18			0.12	0.15		
" " "	800	18			0.144	0.125		
shavings			30		0.10			
shavings, planer (various woods)	190		32		0.059			
shredded wood	40		32		0.056			
" "	100		32		0.052			
wood wool acoustical, fluffy	42		20		0.040			

* Thermal conductivity values are calculated from an empirical equation with moisture content and density as variables. Values for along the grain are between 2.25 and 2.75 times across grain values. An average value for specific heat capacity has been taken.

APPENDIX D

Samples of Education Material distributed by the Office of Energy and Conservation, Department of Energy, Mines and Resources, Canada, and the United Kingdom Department of Energy.

APPENDIX D (*continued*)—

Fat Energy Bill is heading your way!

Nobody wants a visit from Fat Energy Bill. But we're all faced with him this winter.

Look at the weight he's put on.

In the last 12 months, prices of electricity and coal are up by a half.

Gas is up by a third.

And oil prices, since 1973, have more than doubled.

What can a girl do to make Fat Energy Bill keep his distance?

A little good housekeeping, that's what.

There's no need to put your mixer in mothballs. Or your liquidiser or hairdryer. Most labour-saving devices use very little energy.

There are two big ways to save your family money:

1. Save heat. By only heating the rooms you're in, for instance. And, if you have central heating, by setting your thermostat a few degrees lower than last year. Say 67° instead of 70°. We doubt if you'll notice the difference.

2. Save hot water. Lots of things here. Like not washing up under running taps. Keeping the washer waiting till you've got a full load. And force your husband to put a much thicker jacket on your hot water tank. (Don't worry about the airing cupboard. It'll carry on airing.)

SAVE IT

There's much more you can do, of course. If you'd like a free booklet, fill in the coupon below.

We'd like to help you keep Fat Bill at bay.

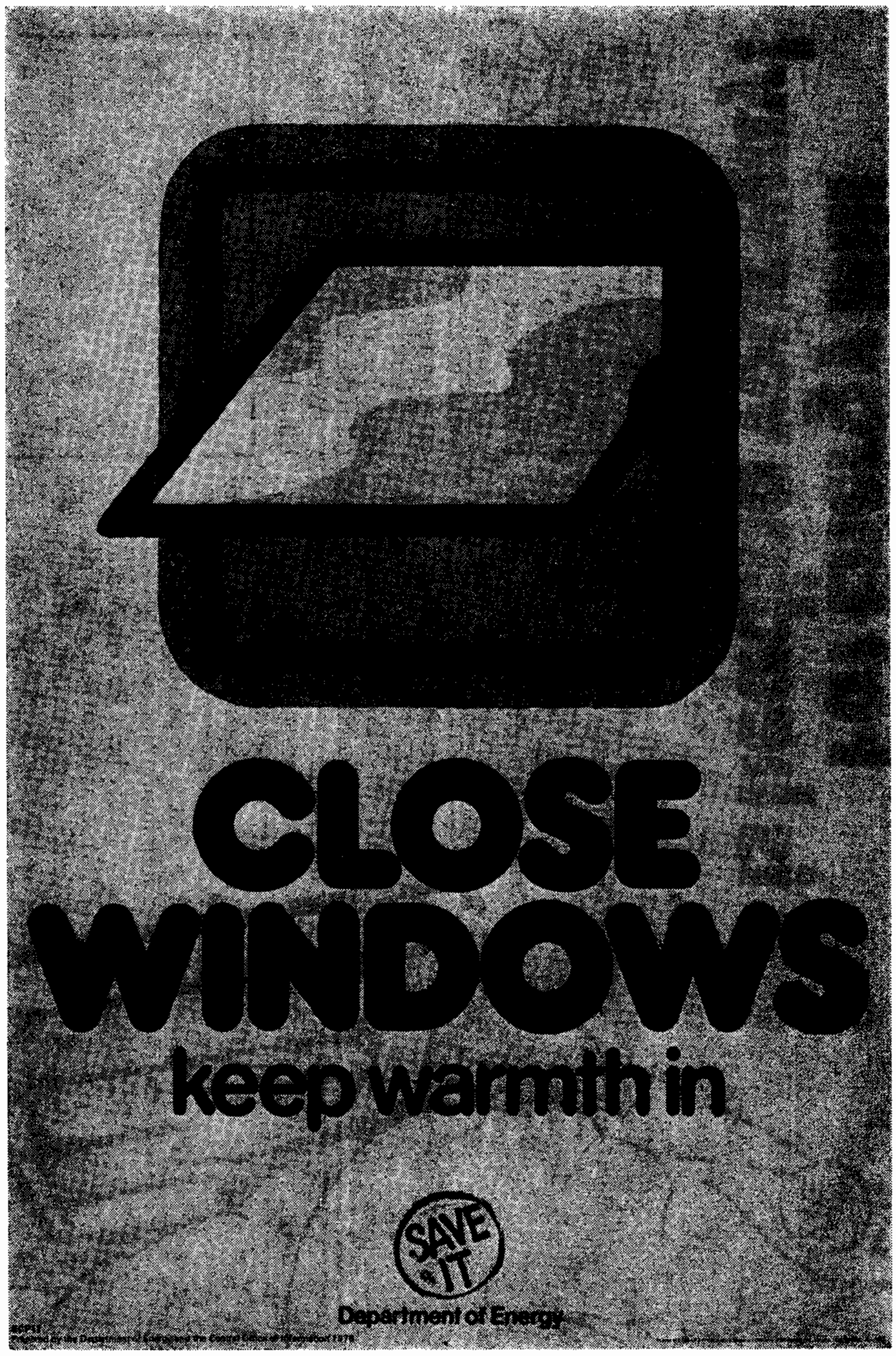
To: Energy Saving in the Home, PO Box 702, London SW20 8SZ.
Please send me a free booklet.

Name________________

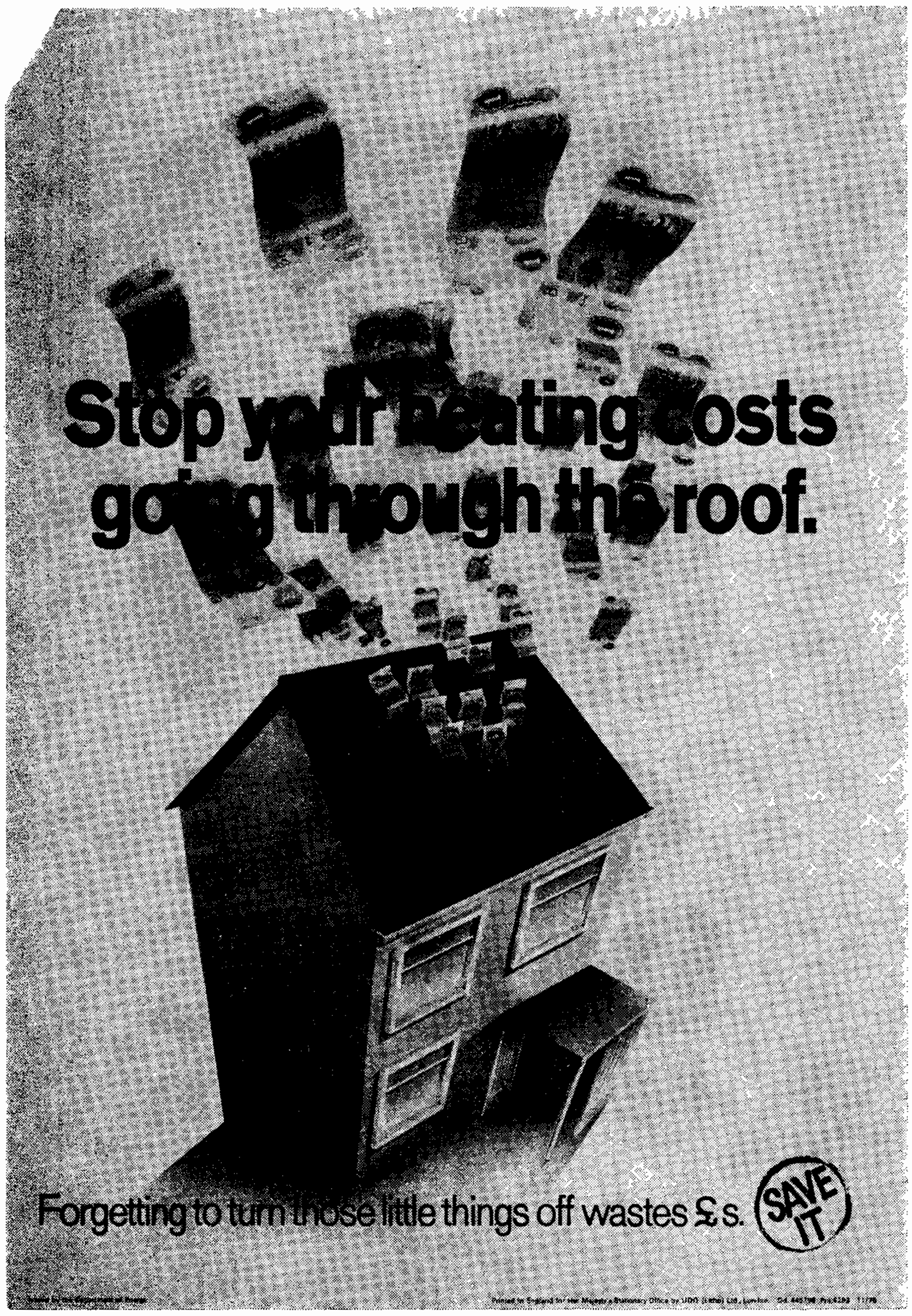
Address________________

Department of Energy.

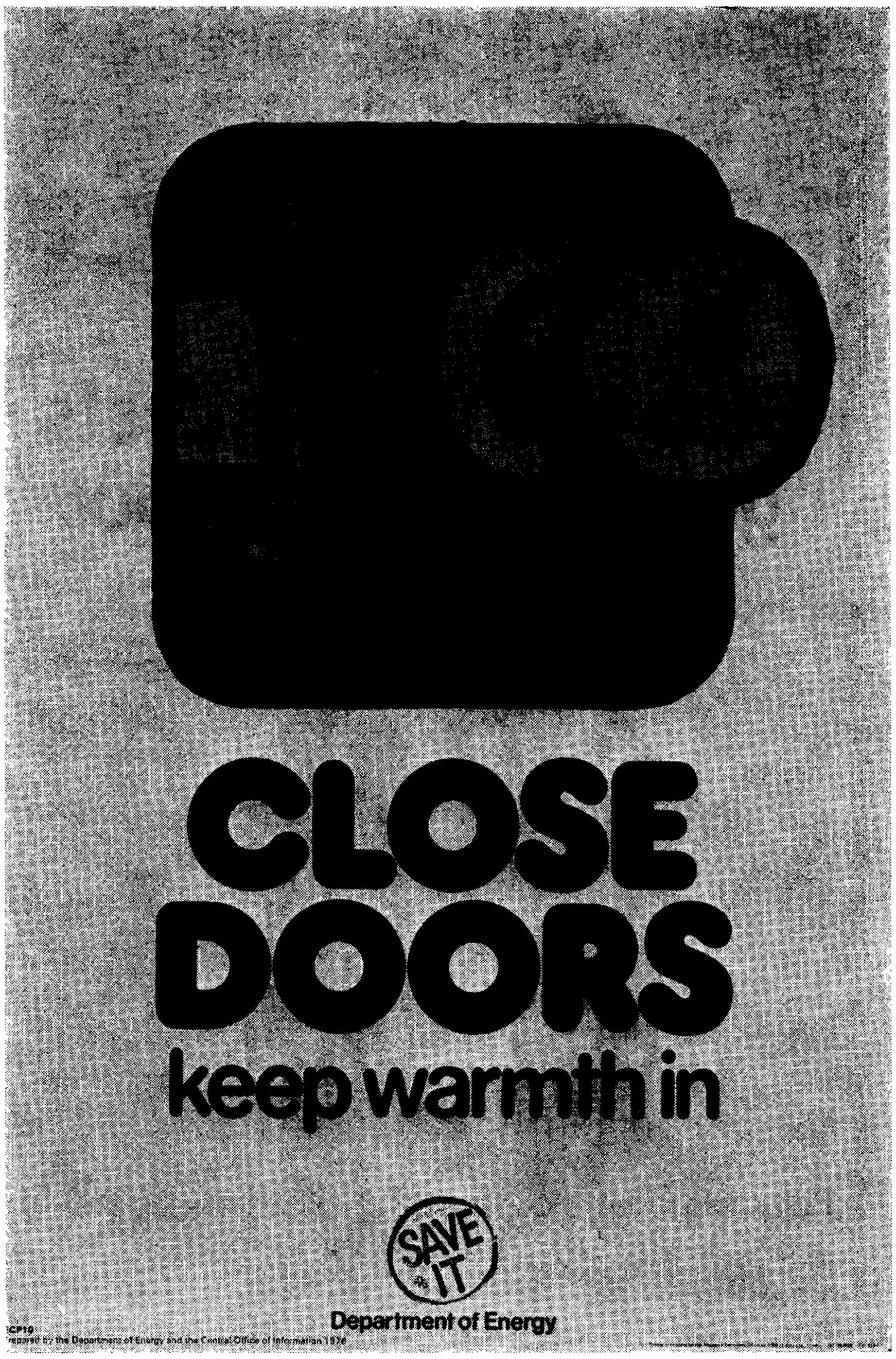
APPENDIX D (*continued*)—



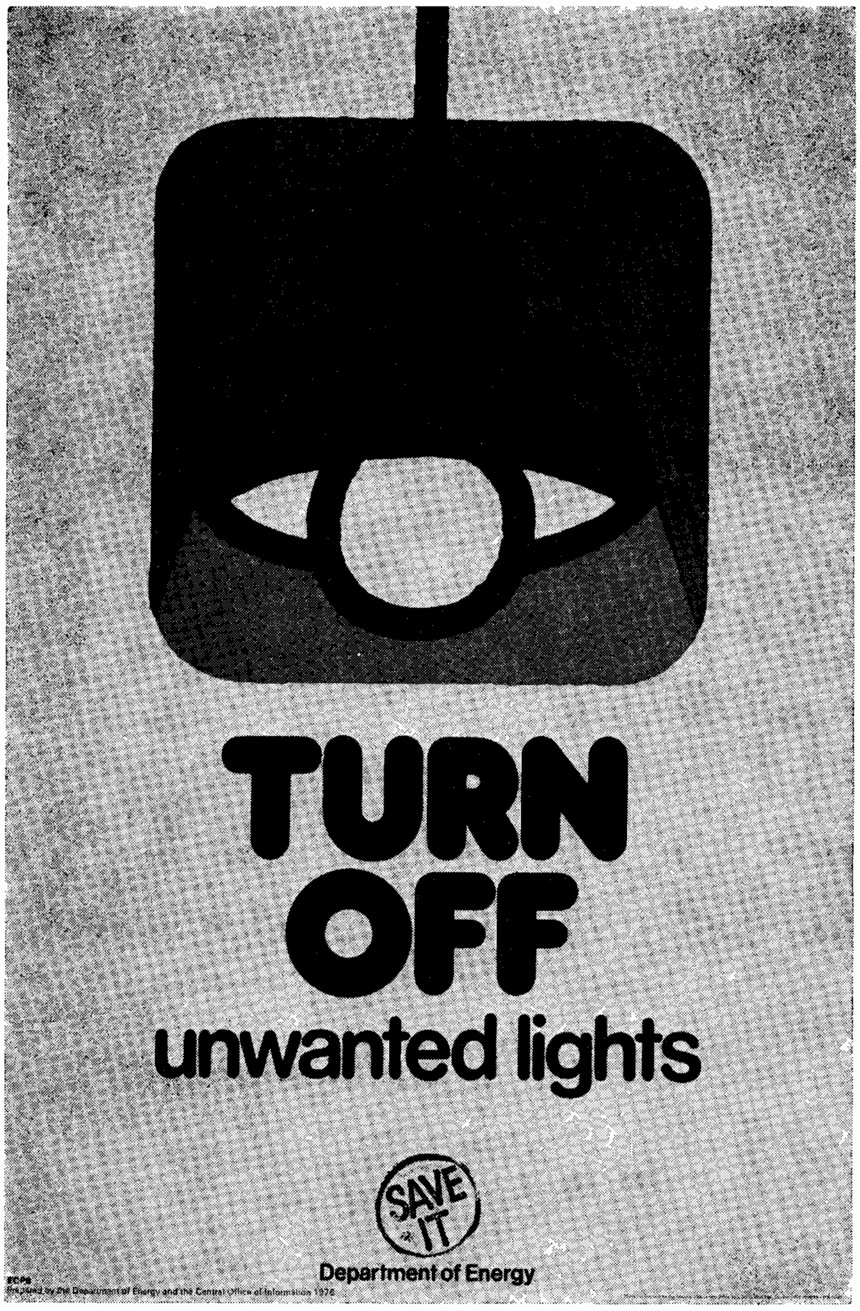
Appendix D (*continued*)—



APPENDIX D (*continued*)—



APPENDIX D (*continued*)—



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