PLANNING AND LAND MANAGEMENT
ACT Government

PPN13

ENERGY GUIDELINES 1993

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PREFACE

In consultation associated with the drafting of the Territory Plan, conservation and industry groups stressed the importance of establishing clear procedures and environmental planning criteria in the interests of economic efficiency and development sensitive to protection of the environment.

This Guideline is one of a series of Environmental Planning Guidelines prepared in accordance with clause A2 of the Territory Plan. This clause allows the Planning Authority to prepare planning guidelines to provide more detailed provisions to guide development than are contained in the Territory Plan. The Environmental Planning Guidelines identify the criteria, procedures or practices to be adopted in meeting the environmental requirements of the Territory Plan.

The Guidelines have been prepared as part of the Plan and also in a manner that can be effective as a stand-alone report. The Guidelines will be reviewed to implement any agreements made by the ACT in fora such as the inter-governmental agreement on the environment. They will also facilitate the identification of joint criteria where requirements touch upon the functional responsibilities of other agencies, in which case the Guidelines have been prepared in consultation to ensure coordination across the ACT Government.

The Guidelines are intended, as far as possible, to provide a consistent and objective approach that the Authority shall have regard to in assessing whether development proposals meet the environmental principles and objectives in the Plan. However, the Authority must take into account a range of planning considerations in assessing development proposals. In some cases it may be necessary to allow developments which do not totally comply with the Guidelines where the meeting of other planning objectives is considered by the Authority to take priority.

Nothing in these Guidelines infers an approval under the Land Act, or exempts from requirements under the relevant pollution control legislation.

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1. INTRODUCTION

As a signatory to the intergovernmental agreement on the environment (IGAE), the ACT will be a member of the new National EPA and will be committed to achieve agreed national standards in such areas as ambient air quality, assessment of contaminated sites, vehicle emissions and noise relating to amenity. In response to these policies the ACT Planning Authority is developing planning guidelines that reflect energy efficiency criteria.

The consumption of energy produced from non-renewable resources results in the gradual depletion of these resources along with associated environmental degradation and the production of greenhouse gases and other pollutants. There is a need to develop ways to reduce consumption of these forms of energy without lowering our standard of living. The ACT government has proposed policy commitments and specific actions to reduce energy consumption and greenhouse gas emissions as part of its environmental strategy.

Some 26% of all energy use and 44% of electrical energy use in the ACT is for domestic purposes and of this, about 50% can be attributed to space heating. Improvements in housing design, orientation and building materials offers the potential for significant energy conservation. For example, various studies have shown that building orientation can reduce energy consumption by up to 37%, dependent on the climate and the standard of building design.

Commercial, government and industrial buildings consume 26% of the energy in the ACT. The Building Owners and Managers Association (BOMA) in New South Wales has been surveying energy use in non-residential buildings since 1979. According to their studies there is potential for making considerable energy savings, up to 50% in some cases, in all types of buildings as the result of an energy use study linked with an energy management program.

A region with a sunny climate such as Canberra has a great potential for energy conservation through orientation of buildings to maximise passive solar climate control thereby reducing requirements for active heating and cooling. Building design including the insulation capacity of building materials, location of windows and size of eaves is also important in determining the effectiveness of orientation. The use of these techniques to achieve energy efficiency should be considered in conjunction with energy efficient appliances and lighting. Energy labelling of domestic appliances allows the selection of more efficient products. Ventilation, heating, cooling and lighting systems in commercial buildings can also be designed for maximum efficiency.

In view of the need and potential for energy conservation in buildings, the Territory Plan stipulates that proposals for residential subdivisions of over 30 blocks include an energy audit of the proposal, and that proposals for non-residential buildings over 2000 square metres GFA include an energy conservation plan. Section 2 of these Guidelines provide details of the requirements to be met in the preparation of energy audits of residential subdivisions and section 3 covers energy conservation plans of non-residential buildings. Section 4 covers the mandatory insulation requirements in respect to external walls of residential buildings. Section 5 describes the procedure for energy efficiency rating for houses, and Section 6 contains general advice on how to site buildings in relation to other buildings to prevent overshadowing, and on energy efficient building design.

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While these Guidelines do not have statutory effect in relation to approvals granted prior to the release of the Guidelines and land uses, they do provide guidance on the desirable practices in respect to those uses.

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2. ENERGY AUDITS OF RESIDENTIAL SUBDIVISIONS

2.1 Rationale behind energy audit

One of the objectives of energy conservation is to heat and cool dwellings with the minimum use of energy. Room comfort can be achieved in this way through the management of solar access, which means that sunlight should be able to penetrate the dwelling in winter and be excluded from the dwelling in summer.

Solar access in winter is achieved through orientation of living areas in dwellings to receive the greatest amount of sunlight. The solar heat gain is greater in winter than summer as the sun is lower in the sky and hence the angle of incidence to vertical windows is less. Exclusion of sun in summer can be achieved through design of eaves, the insulation capacity of building materials and the use of appropriate landscaping.

It has been established in various studies of passive solar housing design that the ideal orientation and proportion of a dwelling to maximise the use of solar energy is a rectangular plan with the sides in a ratio of 1.5:1 to 1.6:1 and with the long axis of the dwelling running in a generally east-west direction within an arc of 20 degrees north to 30 degrees south of east. If there is a preference, then about 10 degrees south of east is best to let more sun in during the early morning in winter. The principles of passive solar house design are explained in greater detail in section 4.

It is considered that the greatest opportunities for cost effectiveness in energy conservation arise where land subdivision and housing layout are conceived and executed together, so that as many buildings as possible can be sited according to passive solar house design principles and are not allowed to overshadow other buildings and thus block their solar access. However, apart from integrated developments where a group of dwellings is designed and built together, the subdivision of land and the construction of dwellings usually occurs as discrete events and is undertaken by different proponents. It is thus necessary to consider at the subdivision stage whether sufficient opportunities will be provided by the block layout for leaseholders to later build dwellings for optimal solar access. This is commonly referred to as achieving a solar efficient subdivision.

Principles of solar efficient subdivision

Blocks within the subdivision should ideally be oriented and proportioned so that a dwelling could be built on the block with the living areas able to receive sufficient sunlight for passive solar climate control, as follows:

> since most houses are rectangular in shape and tend to be built parallel to the boundaries, they are most easily sited with correct orientation on those blocks which run principally north-south or east-west, with the north-south boundary within the arc of 20 degrees west and 30 degrees east of north. Rectangular rather than splay shaped lots allow the best opportunities for solar orientation and lot yield efficiency.
>
> along streets running east-west the side of the block adjacent to the street should be wide enough to accommodate the long side of the building, including driveway access and/or minimum distances to boundaries. (see figure 2.2).

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- along streets running north-south the long side of the block should be oriented east-west to allow north facing orientation of the building. The width of the block should be sufficient to prevent overshadowing from neighbouring blocks. (see figure 2.3)

- on streets that run diagonally, lots may be skewed to achieve northern aspects. Alternatively lots may be of a size to accommodate skewed houses (see figure 2.4).

Difficulties arise in siting houses on blocks at about 45 degrees from north since the house would need to be at an angle to the block boundaries for correct solar orientation. Lots with an area in excess of 450 square metres are normally large enough for such an orientation to be achieved without special requirements in respect of lot dimensions and orientation. However this reduces the possible size of the dwelling that can fit on the block and/or creates awkward corners in outdoor areas adjacent to the dwelling.

To accommodate dwellings with suitable orientation on blocks with an area less than 450 square metres it is preferable that they be located on streets running east-west with the northern wall running parallel to the street. Dwellings may be offset from adjacent dwellings to the north as a technique to allow for solar access on smaller blocks.

Other factors relating to orientation and siting of dwellings have an effect on the layout of a subdivision. Because shadows cast by trees and buildings on north facing slopes are shorter than those on other slopes, a higher density of dwellings may be achieved on these slopes while still maintaining acceptable levels of solar access. Southern slopes (if steep) may require large allotments to maintain solar access, and the height of trees would need to be severely restricted.

Allowances for the following factors would also need to be made in determining the subdivision layout, which in some cases may be contrary to achieving optimal solar orientation for the maximum number of blocks:

- the slope and orientation of the land and the existence of geological features which prevent the desired orientation

- achieving a cost-effective street layout design and block yield per unit area

- the desirability of retaining special qualities or features such as trees or views

- maintaining continuity of natural drainage paths.

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Figure 2.1 - Orientation on east-west streets

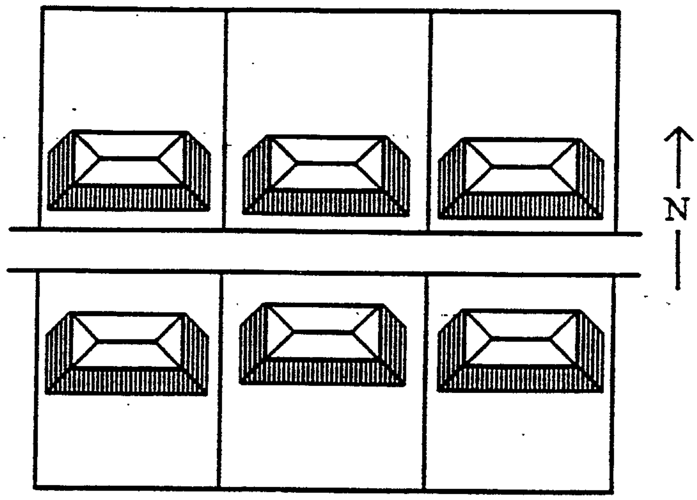


Figure 2.2 - Orientation on north-south streets

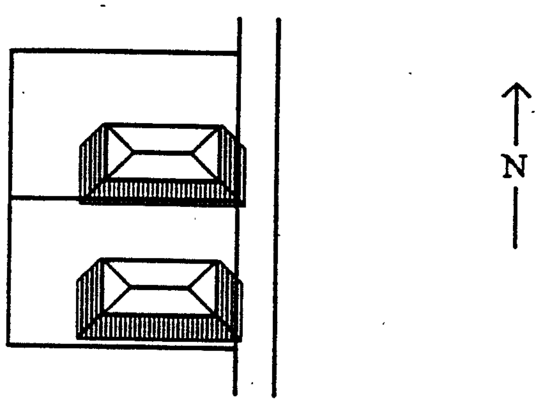
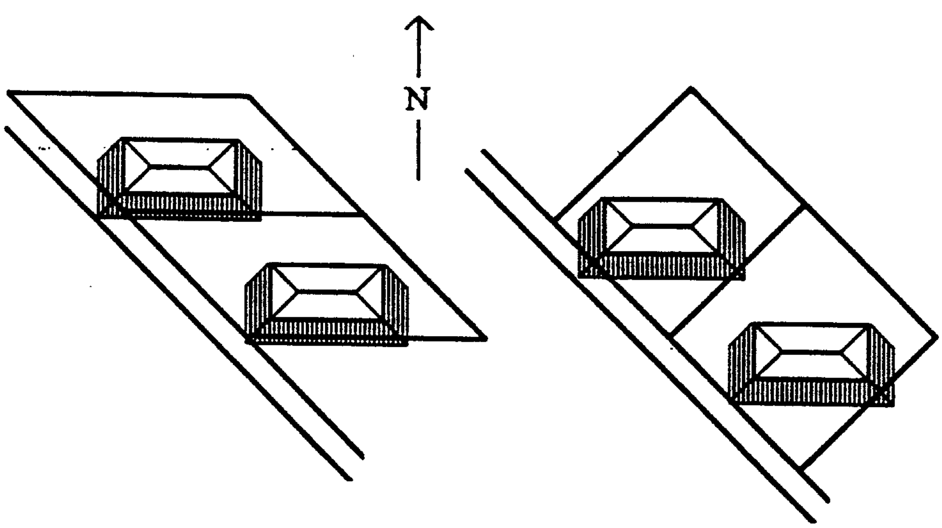


Figure 2.3 - Skew Lots



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2.2 Procedure for conducting energy audits

In determining how the audit should be undertaken it was necessary to take into account 3 principles of solar efficient design -

- *achieving optimal block orientation towards north for solar access;*
- *preventing overshadowing of the northern wall of a dwelling by adjacent buildings;*
- *maximising the possible length of the north-facing wall of a dwelling within a block;*

within the constraints imposed by the variable nature of block sizes and the trend towards smaller blocks for urban consolidation.

The approach therefore adopted has been to establish a Energy Efficiency rating scheme for blocks which allows the relative solar efficiency of different blocks to be compared and to give future purchasers a clearer idea of the potential of particular blocks for providing the correct siting for passive solar housing. This was seen as fairer than a pass/fail audit process where there is no recognition given to whatever solar efficiency characteristics that a failed block has.

The attempt has been made in the rating scheme to account for the range of block sizes. By their nature, smaller blocks have greater difficulty in achieving the same level of solar access as larger blocks due to the smaller separation between dwellings and limited opportunities to angle the dwelling on the block. With careful subdivision design it is possible under the rating scheme for smaller blocks to get at least a rating of 3 and often 4, while some will achieve a rating of 5.

The rating scheme involves an examination of 3 different block orientations relative to north and whether zero setbacks would or would not apply to these orientations (walls on zero setbacks have no windows so this can pose a major constraint on solar entry into a dwelling). Many of the block dimensions specified in the criteria are derived from an attempt to provide a standard building envelope on the block of 15 metres x 10 metres within the constraints of the design and siting policies in the Territory Plan and sufficiently separated from buildings on the northern side of the block to ensure some solar access. This envelope size is taken from the Australian Model Code for Residential Development and represents an area in which an average size dwelling could be sited.

The Territory Plan stipulates that:

> All proposals for residential subdivisions of over 30 blocks include an energy audit of the proposal.

The aim of the energy audit is to make clear to the Authority and to the public the extent to which a subdivision proposal maximises the opportunities for leaseholders to build dwellings with ideal proportions and orientation for passive internal climate control utilising solar

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energy. The extent of solar access provided is judged by the percentage of blocks of suitable orientation and dimensions that allow an average size dwelling to be sited on the block preferably with its long axis running in a generally east-west direction whilst still maintaining acceptable setbacks from boundaries.

Information to be provided

A site plan of the area at a scale of at least 1:1000 must be provided, showing the street and subdivision pattern, contours, and trees remaining after the subdivision work is complete. The area and boundary dimensions and bearings of each block must be shown on the subdivision pattern. Nominated zero setback boundaries should also be marked. The proposed use of each block should be indicated, ie -

residential blocks
sites for multi-unit developments
non-residential Land Use Policy (indicate which Policy)

Audit process

The audit process involves rating each block against a 5 tier rating scheme. The rating of a block is calculated by first determining which of the 3 criteria listed in table 2.1 below would apply to the block. In the case of the first 2 criteria, the frontage dimension of the block is then matched against the figures in the 4 columns to determine the rating of the block. In the case of the third criteria a standard building envelope of 15m x 10m must be fitted onto the block with the required setbacks as described in note 5 below. Blocks which do not meet any of the criteria receive 1 star only.

Audit presentation

Each block on the plan should be marked with its star rating. A summary table should also be provided showing the following information -

Rating	Number of blocks	% of total
5		
4		
3		
2		
1		
Total		100%

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Table 2.1 - criteria for determining block rating

	Rating	2	3	4	5
Criteria		Minimum frontage dimension (metres)[1]			
(a) blocks facing an east-west street[2] - see figure 2.6					
	no zero setbacks	<15	15	17	19
	one zero setback	<13	13	15	17
	2 zero setbacks	<9	9	11	13
(b) blocks facing a north-south street[2, 3] - see figure 2.7					
	no zero setbacks	<14	14	16	18
	a zero setback on southern boundary[4]	<12	12	14	16
(c) any blocks not able to be rated under criteria (a) or (b) - see figure 2.8		Minimum distance from northern boundary			
	see note 5 for details of criteria	--	2	4	6

Notes:

1. Where the front boundary is curved or contains angles the line between the main corners of the block should be used instead. Where the block is a skewed block the perpendicular line between the side boundaries should be used instead of the front boundary line.

2. The permissible orientation range for block boundaries is 20° west to 30° east of north, and 20° north to 30° south of east. This is illustrated in figure 2.5.

3. For sloping blocks the following adjustments should be made to the frontage dimensions -

	Slope aspect	
slope of land	N, NE, NW	S, SE, SW
5% - <10%	-1 metre	+1 metre
10% - <15%	-2 metres	+2 metres
15% - <20%	-2.5 metres	+2.5 metres

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4. A block with a zero setback on the northern boundary will receive a rating of 1.

5. A building envelope of dimensions 15m by 10m must be able to be sited on the block such that the 15m side runs in an east-west direction within an arc 20° north to 30° south of east <u>and</u> the following minimum distances from boundaries are met -

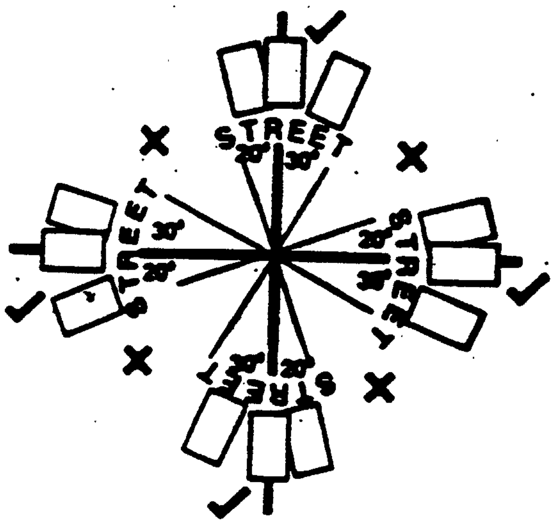
   - 4 metres from the front boundary

   - 2m from other boundaries which face SE, S or SW, where not a nominated zero setback boundary

   The block rating is determined by the distance from the building envelope to the side or rear boundaries which face north, NE or NW in accordance with the rating table.

   It is acceptable to angle the building envelope on the block to achieve the setback distances.

Figure 2.4 - permissible block orientation



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3. ENERGY CONSERVATION PLANS FOR NON-RESIDENTIAL BUILDINGS

3.1 Requirements for Energy Conservation Plans

The effectiveness of energy management programs in existing non-residential buildings, with the potential for making considerable energy savings of up to 50% in some cases, points to the need for new building developments to be designed for energy efficiency in the first instance. This is also economically effective as it will reduce the on-going energy costs of the building in the long term.

Energy saving measures can be designed into buildings at little or nil additional cost through passive features such as orientation, building shape, window design, insulation etc. Similarly some active design features also cost very little. However, additional equipment such as a waste heat recovery plant may require greater initial capital cost in order to reduce ongoing energy consumption and associated costs. However, studies of energy management programs have shown that a 3 year payback on energy efficiency measures is readily achievable.

The aim of an Energy Conservation Plan for buildings is to establish measures to conserve all forms of energy by encouraging the efficient use of energy and, where possible, to provide substitutes for non-renewable energy resources.

Energy usage data for buildings is essential for evaluating the energy performance of existing buildings and for establishing energy criteria in the design of new buildings and systems. To this end the Territory Plan contains the following requirement:

> An Energy Conservation Plan is required for building proposals over 2000m^2 GFA for assessment as to its energy efficiency.

Energy Conservation Plans are not required for industrial warehouse type buildings which have no heating or air-conditioning systems.

The Energy Conservation Plan should give details of all energy consumption within the building, including -

- a description of all energy-consuming elements of the building
- the type and amount of energy used for each element
- calculation of energy consumption in MJ/m^2/annum for each element.
- total building energy consumption in MJ/m^2/annum

The energy conservation plan should be prepared by persons who are professionally qualified to undertake such work. The Institution of Engineers, Australia, maintains a register of accredited energy auditing organisations from which an appropriate agent can be selected.

At the time of seeking development approval the building services and construction details to be incorporated within the building may not have been finalised and thus energy consumption figures could not be calculated accurately. It is therefore acceptable in such cases to supply an interim conservation plan describing -

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- the impact of the design and siting of the building and its particular design features on its likely energy consumption, eg. the building's size and shape, orientation, extent of glazing, and types of building materials being used;

- the types of building services to be incorporated into the building and their likely energy consumption in general terms;

- any targets for energy consumption that have already been determined for the building.

A full energy conservation plan should then be supplied to the Authority at the time of seeking building approval.

ACT Public Works and Services, Department of Urban Services, provides technical advice and services to proponents seeking understanding and application of energy conservation principles in buildings through its

ACT PUBLIC WORKS & SERVICES ENERGY FORUM
P.0. BOX 56
CANBERRA ACT 2601

Energy consumption targets

An interim set of energy consumption targets has been adopted, pending the development of a nationally coordinated set of energy performance criteria for buildings which is currently in progress. This task is difficult as a wide range of factors are involved in reducing energy consumption and expenditure in non-residential buildings. These include:

- building siting, design and construction
- end use of the building
- plant and equipment selection and operation
- choice of energy source
- occupant behaviour

Table 3.1 gives the energy consumption targets for ACT buildings, based on the "specific energy indices" developed by the Australian Construction Service (ACS) for cities throughout Australia, and is amended with respect to performance measures compiled by ACT Public Works. The indices are based on reasonable efficiency with room for improved efficiency. These indices are used by ACS for setting targets for building performance using a method described in the following article - "Reasonable targets for low energy building design and operation" by A M Brown, C R Broadbent and P W Dobney, *Australian Refrigeration, Air Conditioning and Heating*, June 1985. Revised indices relating to the above method were published in "Reasonable targets for low energy building design and operation - Revised indices from further research" by A M Brown, J M Fricker and A R McKenzie, *Australian Refrigeration, Air Conditioning and Heating*, September 1986. The method is also described in "Calculation of Energy Targets" by A M Brown, P W Dobney and J M Fricker, *ASHRAE Journal*, October 1987.

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The Building Owners and Managers Association (BOMA) have published *Energy Guidelines for Building Owners and Managers* (1986), which contain energy conservation guidelines for commercial buildings. This provides useful background information for the design of specific buildings.

Development proposals for building types that do not yet have an energy consumption target as in table 3.1 would still need to demonstrate through the energy conservation plan that an effort has been made to achieve a reasonable level of energy efficiency.

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TABLE 3.1 ENERGY CONSUMPTION TARGETS FOR BUILDINGS IN THE ACT

Building Type	Nominal Hours	Specific Energy Indices (MJ/m²/annum)						
Non-Residential		Interior Light	General Power	Heat[1]	Cool[2]	Fans & Pumps	Lift	HWS
School (A/C)	1000	30	15	68	75	20	n.a.	11
Office	2000	65	23	75	80	25	13	3
Store	2500	60	10	112	120	30	n.a.	11
Workshop	2500	100	45	112	120	50	n.a.	22
Laboratory	2500	140	60	195	240	100	20	43
Hospital[3]	8760	350	150	750	360	200	60	194
Telephone Exchange	8760	300	90	300	320	150	40	11
Residential								
Barracks[4]	4000	80	20	225	104	40	n.a.	108
Multi-Family	8760	25	125[5]	375[6]	-	n.a.	n.a.	173

Notes:

8760 = continuous occupancy
4000 = off-duty on-base hours (from 5.00pm to 7am, 6 days/week, 285 days/year)
2500 = office work hours (from 8.00am to 6.00pm, 5 days/week, 250 days/year)
1500 = public sector school hours (from 8.00am to 3.30pm, 200 days/year)

(1) Heat includes ancillaries but not transport of heated air or water to the conditioned spaces.
(2) Cool includes ancillaries but not transport of heated air or water to conditioned spaces.
(3) Hospital includes ward and theatre blocks only.
(4) Barracks includes dormitories with any dedicated laundry facilities.
(5) Includes 65 $MJ/m^2/a$ for cooking.
(6) Heated from 7.00am to 10.00pm, 7 days/week for the heating season.

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3.2 Principles of energy efficient non-residential buildings

The following are some points that should be considered in designing non-residential buildings. The application of particular points would depend on the siting and use circumstances of a proposed building. Although use of passive solar systems is desirable in all buildings, it is recognised that with the scale and complexity of most non-residential buildings it is usually necessary to combine passive solar systems with the use of active systems such as for heating, cooling and lighting.

Buildings

The building structure should be designed to present a thermally efficient barrier to the external elements so that heat losses and gains are appropriate for the time of year. Where possible the building should be orientated with its long axis running generally east-west. The building should be well insulated. Windows facing north should have sufficient overhangs to exclude the sun during the summer months and allow passive solar heating during the winter months. Windows facing east and west should be minimised and shaded or screened to exclude early morning and late afternoon summer sun.

Heating

All heating systems should have sufficient means of control to ensure that:

- areas are only heated when occupied; and
- areas are only heated to the required temperature.

Time clocks should be used to ensure heating does not operate outside the hours of building occupation. Thermostats should be used to prevent overheating. Thermostats should be located away from windows, machines and furniture. They should register the temperature representative of the general space.

Boiler systems are inherently the least efficient. Long reticulation and high temperatures further decrease the efficiency. Separate heating systems should be provided for areas which require heating after hours or at irregular periods.

Air conditioning

Major problems in air conditioning systems occur when heating and cooling plant have the potential to operate simultaneously. When strict control of temperature levels or humidity is applied to this type of system, the heating and cooling plant will compete against each other in an effort to maintain the desired conditions and thus waste energy.

All cooling systems should be thermostatically controlled. Equipment requiring exact temperature control or extended operating hours should have dedicated cooling equipment and be partitioned off from the rest of the air conditioned space. Zoning of space to take into account solar radiation inputs at different sides of the building should be considered.

Ventilation systems associated with heating and cooling systems should be of the recycling type with a limited amount of outside air supplied to these buildings as this quantity of air has to be cooled or heated to building temperature before it enters the occupied space. The

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automatic variation of this outside air volume to take advantage of suitable outside air temperatures will reduce heating and cooling requirements throughout the year.

Evaporative cooling can be very economical and effective. Heating systems should not be integrated with evaporative cooling as there is no recirculation and air quantities are excessive. Radiant heaters are the most effective form of heating in this case.

The use of direct digital control (DDC) technology can provide more precise and quicker response to changing temperature requirements. Heat-recovery systems can draw waste heat from internal sources such as lighting and computers and recirculate it to other parts of the building.

Lighting

Improvements in the energy efficiency of lighting systems can be achieved in various ways:

- Use of the most energy efficient luminaries. The efficiency of lamps available, ranges from approximately 10 lumens per watt for a typical incandescent lamp to almost 200 lumens per watt for a high capacity low pressure sodium lamp.

- Better matching of lighting levels to occupant activities, rather than a standard lighting level throughout the building. Low general illumination levels could be matched with greater use of user-controllable task lighting.

- Installation of an effective lighting control system so that unwanted lighting can be switched off either manually or automatically. A small group of luminaries operated from switch is preferred to a whole floor area from one switch. Automatic switch controls could be timed for when staff are not normally present.

- Integration of electric lighting and daylight through daylighting sensors which can automatically adjust illumination to changing natural light conditions.

Water heating

Water heating can be made more efficient through adequate insulation of storage tanks and pipes, reduction in reticulation lengths, and lowering of temperature level to match application.

Lifts

Reducing the number of unnecessary starts is the most effective means of increasing the energy efficiency of lift installations. For example this can be achieved through stopping lifts at last station of call rather than returning to a pre-set floor, better placement of occupants within the building to lessen interfloor movement, and promotion of the use of stairs through ease of access and signage.

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4. RESIDENTIAL BUILDING INSULATION REQUIREMENTS

4.1 Requirement for Insulation of External Walls

The incorporation of insulation into building construction substantially reduces the amount of heat entering a house in the summer, and leaving a house in winter. The savings in energy afforded by insulation are such that the additional cost incurred in installing insulation is recovered in two years. The benefits of solar access can only be fully exploited in association with insulation.

As the conservation of non-renewable resources, and the reduction of air pollution and Greenhouse Gas emissions are community wide concerns, there is a requirement to move towards full insulation of all housing in the ACT. While insulation of ceilings may be added at a later date, effective and economic insulation of walls is best secured at the time of house construction.

All external walls of residential buildings are required to incorporate insulation, of a type and thickness such as to yield an effective R value of not less than 1.7 (refer to Section 6.2 and Table 6.3 of these Guidelines for information on effective R values).

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5. ENERGY EFFICIENCY RATING SCHEME FOR HOUSES

> *This rating scheme brings together the principles of passive solar house design in a checklist by which the relative energy efficiency of different houses, both old and new, can be compared. Each energy efficiency measure in the checklist is given a number of points, and the total number of points that can be granted to a particular house gives an indication of its relative energy efficiency. However, this method of weighting different measures should only be regarded as giving a general indication of the relative benefits of different energy efficiency measures. The research into energy efficient housing is not at a sufficiently advanced stage to enable a precise quantification of the energy savings that can be made by employing one energy efficiency measure relative to another, or of only partly achieving the ideal quantities of a particular measure. In addition, many of the individual measures listed in the checklist depend on other measures also being taken to ensure that the full potential of the measures is realised. It should also be noted that the energy savings ultimately attained in a particular house are very much dependent on the behaviour of its occupants in making full use of the energy saving features of the house and in being aware of their own energy consumption patterns.*
>
> *Moves are underway at a national level to develop a more precise rating scheme, unfortunately this work is not completed at this time. In the interim, the simplified rating scheme presented here will still give a good indication of the relative energy efficiency of different houses.*

The Territory Plan is to be varied to stipulate that:

Any application for approval of the external design and siting of a new dwelling is to be accompanied by an Energy Efficiency Rating statement in accordance with the ACT Planning Authority's Energy Guidelines for Buildings (Part 5) and carried out by an accredited organisation.

When assessing an application for approval of the external design and siting of a new dwelling, the Authority shall have regard to the orientation of and provision of external glazing to habitable rooms of the dwelling, using the Energy Efficiency Rating statement for guidance. Where the orientation and glazing aspects of the Rating are poor, the Authority may require the applicant to demonstrate special circumstances and may refuse the application.

The aim of the energy efficiency rating is to make clear to the Authority and the public the extent to which the proposed house orientation and design maximises the opportunities for conservation of energy and for utilisation of passive solar heating.

<u>Information to be provided</u>

To assist in the implementation of the above policy, the ACT Planning Authority will require the following information to be provided with an application:

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1. a completed checklist from Part 5 of the Energy Guidelines for Buildings, signed by a representative of the organisation carrying out the assessment;

2. a summary table of the EER statement checklist, shown on the face of the main floor plan drawing accompanying the application - the summary table is to show the aggregate point score against each of the main elements of:

- Orientation/Zoning
- Insulation
- Glazing/Thermal Mass - winter conditions
- Glazing - summer conditions

together with the calculation of the overall rating out of '5 stars'.

Assessment process

The assessment process involves assessment of the dwelling against each of the items identified in the checklist. The overall assessment is calculated by dividing the total score by 10.

CHECKLIST

	points	your rating
Orientation/Zoning		
External walls of the house generally aligned with north-south and east-west axes (within arc from 30° east to 20° west of true north) and setback a minimum of 6 metres from the northern boundary.	5	
House is zoned with day-time living areas (living room, family room, kitchen, childrens' play areas) on northern-side of house	5	
Rooms and doorways located to separate and close-off little used and unheated areas from areas which are being heated. - if house more than 1 storey, upper floor areas are also isolated from lower levels by an enclosed stairwell, with a door to the stairwell at the lower level.	2	
Windows and internal doors placed to give good cross-ventilation for summer cooling	1	

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Insulation		
Ceiling - R3.5 insulation R2.5 insulation insulation but < R2.5	7 6 5	
Walls - R2.0 insulation R1.5 insulation insulation but < R1.5	5 4 3	
Party wall with another dwelling - one side of house two sides of house	 2 4	
If timber floor - R1.0 insulation or reflective foil to underside of floor If on-ground concrete slab floor - R1.0 polystyrene insulation along edge of slab If suspended concrete slab floor - R1.0 insulation under all of slab	 1 2 2	
Glazing/Thermal mass - winter conditions		
Daytime living areas have north-facing glass areas (within arc from 30° east to 20° west of true north)	2	
In north floor area, north facing glass area is 25-30% of floor area and exceeds non-north glass in that area - If house more than one storey - north facing glass area in upper storey/s is also no greater than 15% of north floor area in upper storey/s	3	
Concrete slab floor	2	
House construction - If framed construction (eg brick veneer) with concrete slab floor and no internal masonry walls in north floor area - at least 70% of north floor area is hard surfaced. If full masonry walls and timber floor, or framed construction with some internal masonry walls - internal masonry wall area around north floor is at least 80% of north floor area. If full masonry walls and concrete slab floor	 3 3 3	
Total non-north facing glass area is less than or equal to 15% of total floor area	2	

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North facing glass shaded during winter, for example by excessive overhangs, trees or other buildings (minus points)	-5	
Double glazing	2	
Glazing - summer conditions		
Effective west facing glass area is less than or equal to 2.5% of total floor area	1	
Total effective east and west facing glass area is less than or equal to 5% of total floor area	1	
Total effective east and west facing glass area in each individual room is less than or equal to 15% of the floor area of the room - If house more than one storey - no east or west facing glass area in upper storey/s unless totally shaded	1	
Shading of north-facing glazing from summer sun	1	
TOTAL		

Divide your total by 10 to give your house a rating out of 5 stars.

PROCESS

Step 1 - perform the calculations below to derive various statistics about the house that will be used in the checklist.

Step 2 - work though the checklist and give the house the relevant points for each energy efficiency feature that it possesses. Total the points then divide by 10 to give a rating out of 5 stars. Where the calculated rating is not a whole number, round off to the nearest 1/2 star.

CALCULATIONS

(note: do not include bathrooms, ensuites, toilets or laundries in any calculations)

Floor areas

north floor area (total area of rooms with north facing glass*) m^2
other floor area m^2
total floor area m^2

hard floor surface (eg. slate, ceramic tiles or vinyl) on concrete slab in north floor area m^2
% of north floor area

Also calculate the area of each individual room ie an area that can be separated from the rest of the house by doors.

(* - glass in a plane perpendicular to a line within an arc of 30° east to 20° west of true north)

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Internal masonry wall area m²

In and around north floor area only. Includes external walls only where internal lining is masonry. Count single skin walls between rooms only once

Glass areas

(note: this refers to area of glass only and does not include frames)

north facing glass area*	m²	
	% of north floor area	
if house more than one storey - north facing glass area in upper storey/s		
	m²	
	% of north floor area in upper storey/s	
south facing glass area	m²	%
east facing glass area	m²	%
west facing glass area	m²	%
total non-north glass	m²	% of total floor area
effective east facing glass area#	m²	%
effective west facing glass area#	m²	%
total effective east & west glass	m²	% of total floor area

Also calculate the effective east and west facing glass area in each individual room.

(# - see appendix A for definition of effective glass area)

Acknowledgments

The rating system is derived from *the Five Star Design Rating* produced by the GMI Council of Australia in 1985, and from information material on the Five Star Design Rating Scheme and on energy efficiency produced by Energy Victoria and the NSW Minerals and Energy Information Centre.

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Appendix A - Effective glass area

Effective glass area is the measured area of glass multiplied by the shading coefficient of any structures or devices which shade the glass area. The coefficient is based on a fraction of a base condition, being unshaded 3mm clear glass. The lower the coefficient the greater degree of shading provided. Typical shading coefficients are -

3mm clear glass unshaded	1.00
6mm grey-tinted heat absorbing glass	0.69
6mm heat-reflecting glass	0.35
3mm clear glass with:	
indoor roller blinds	
dark	0.80
medium	0.62
light	0.41
indoor venetian blinds	
dark	0.75
medium	0.65
light	0.56
curtains	
dark	0.58
light	0.40
with white linings	0.35
outdoor canvas awning - close fitting	
medium/dark	0.35
light	0.28
outdoor venetian blinds	0.15
shade casting trees and shrubs	
medium density foliage	0.55
dense foliage	0.22

(shading coefficients taken from "Energy Efficient Housing for New South Wales" by Ballinger, Prasad and Cassell, NSW Office of Energy, 1992)

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NOTE

The following sections are provided for the assistance of proponents and the general public in understanding and applying the principles of energy conservation in buildings.

These sections do not form part of the formal guidelines to which the ACT Planning Authority will have regard in accordance with the Territory Plan.

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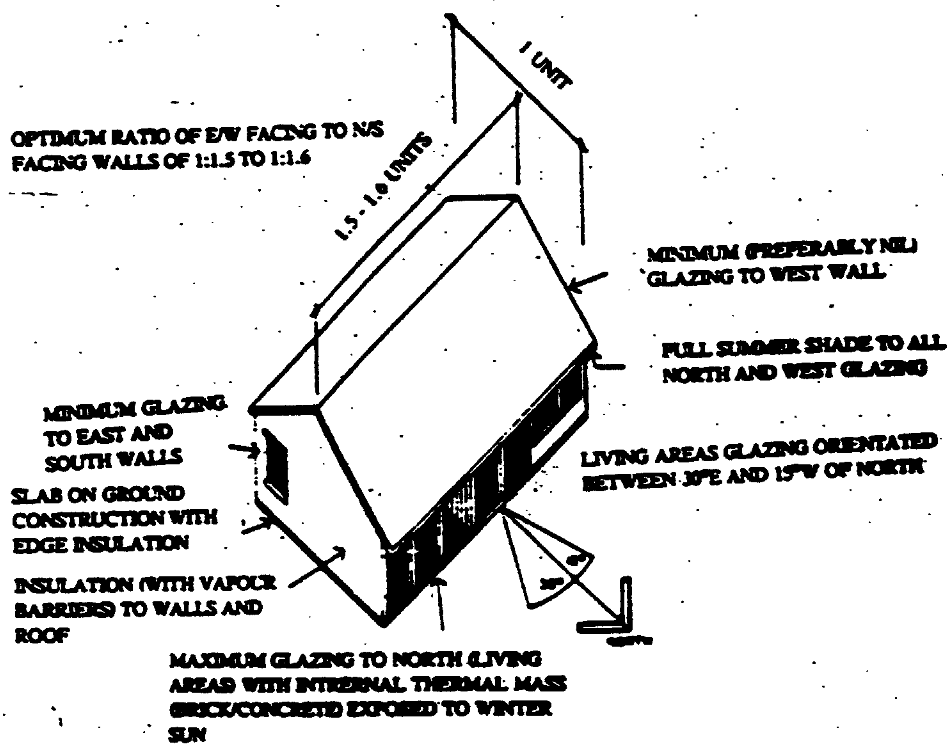
6. ENERGY EFFICIENCY IN RESIDENTIAL BUILDINGS

The principles of energy-efficient passive solar house design are summarised in figure 6.1. It will be noted that the key features are -

- orientation of long side of house to the north, with maximum glazing on the northern wall to capture winter sun and minimum glazing on east and west walls to exclude summer sun.
- insulation in the exterior walls of the house
- thermal mass within the interior of the house

These features are explained in more detail in the following sections.

Figure 6.1 - Summary of passive solar house design



6.1 Building Height and Setbacks

Of particular importance to achieving solar efficient housing from a planning perspective is to ensure that dwellings are not shaded from winter sun by other buildings. It is recognised that there needs to be a trade-off between providing solar access and housing density. Ideally buildings should be far enough away from each other to prevent overshadowing, but the distances may be impracticable to achieve particularly in medium density housing areas and/or where buildings of over 1 storey are being contemplated. As a compromise, blocks in new residential areas should be of a size and orientation so that dwellings can be built on them in which the long side of the dwelling can face north and will receive not less than 3 hours of sunshine between 9am and 3pm in mid-winter.

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To achieve this it is necessary to determine the minimum distances between adjoining buildings so that excessive overshadowing does not occur.

The Authority's Design and Siting Policies for Residential Areas set minimum setbacks from south-east, south and south-west boundaries (ie boundaries orientated greater than 30° east or west of north) necessary to protect reasonable solar access and limit the height of the building on the northern block to control overshadowing.

By nature this policy is generalised and only sets a minimum standard and does not take into account the range of physical characteristics possible for residential blocks. This section therefore provides methods to determine more precisely the boundary setback required for a particular block, depending on its orientation, ground slope and surrounding buildings, to ensure adequate solar access. The first method should be employed to determine acceptable separating distances between adjacent dwellings to ensure that acceptable solar access is provided. The second method may be used to determine the exact mid-winter shadow that a building will cast where this is required for detailed site planning. These methods have been adapted from the *Energy-Efficient Site Planning Handbook* (Kay et al,1982).

Method 1 - acceptable separating distances between dwellings

This method can be used both to ensure that a proposed dwelling does not overshadow existing dwellings to the SE, S or SW, and to ensure that the dwelling is sufficiently separated from dwellings to the NE, N or NW to not allow them to overshadow the dwelling. The distance required between dwellings to allow solar access is dependent on the slope and orientation of the ground and the height of the building to the north. Figure 6.2 describes this process. Table 6.1 gives a distance factor for various slopes and orientation and is used with the height of dwelling to the NE, N or NW to determine the minimum north-south distance (D) between dwellings.

In the case of a proposed dwelling where dwellings to the NE, N or NW have not yet been built and their height is not yet known an arbitrary height of 3m at the boundary line should be used as this is the maximum allowable height at the SE, S and SW boundary according to Design and Siting Policy. The ideal setback from the boundary would thus be 3 times the distance factor according to Table 6.1.

In the case of a proposed dwelling where dwellings to the SW, S or SE have not yet been built, the only action that can be taken to ensure that your dwelling will not shade future dwellings is to ensure compliance with the Design and Siting Policies on setbacks.

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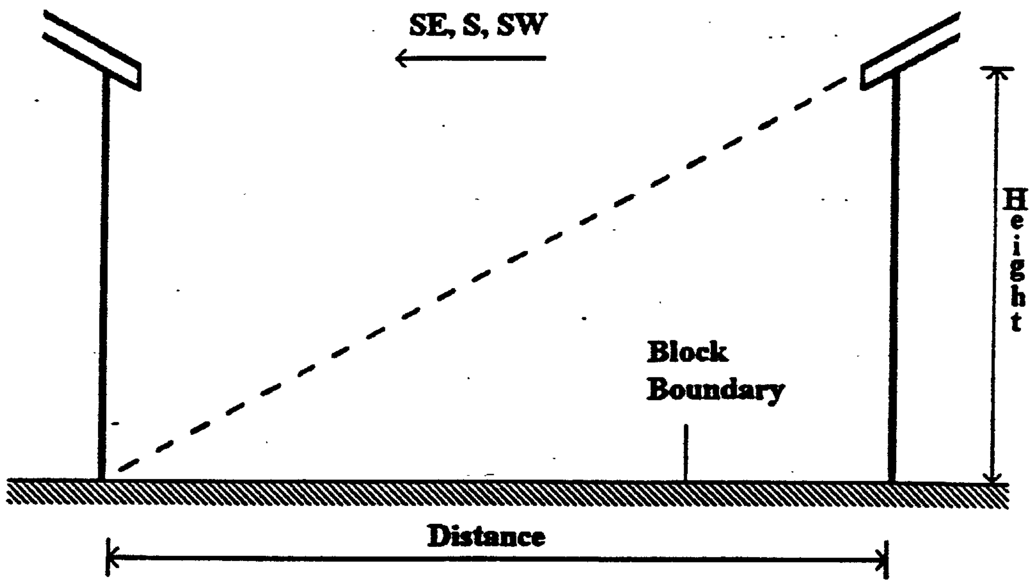
Figure 6.2 - Separating distance for solar access



North-south distance between buildings = Height of northern building X Distance Factor (from table 6.1).

Table 6.1 - Distance factor F to allow 3 hours of solar access.

Slope (degrees)	Distance Factor	Slope (degrees)	Distance Factor
Orientation of slope: S		Orientation of slope: SW	
5	2.2	5	2.1
10	2.7	10	2.4
15	3.5	15	2.9
Orientation of slope: W		Orientation of slope: NW	
5	1.9	5	1.7
10	1.9	10	1.5
15	2.0	15	1.4
Orientation of slope: N		Orientation of slope: NE	
5	1.7	5	1.7
10	1.4	10	1.5
15	1.3	15	1.4
Orientation for slope: .E		Orientation of slope: SE	
5	1.9	5	2.1
10	1.9	10	2.4
15	2.0	15	2.9
Level Ground	1.9		

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Method 2 - calculation of shadow diagrams

The most effective method to determine maximum solar access is to calculate the shadow diagram for a building so that adjacent structures can be located accordingly outside of the shadow region. This method is more detailed and more accurate and is very useful for complex building proposals such as integrated medium-density developments

Shadow diagrams are determined by treating each corner of the building as a pole which casts a shadow calculated using the shadow length table for the ACT (table 5.2) which gives the distance factors for various slopes and orientation at certain times of the day. These factors are multiplied by the height of the pole to determine the length of the shadows cast. The bearing of the sun at different times of day are used to determine the direction of the shadows. The composite of all the pole shadows determines the overall shadow cast by the building. Figure 6.3 describes this process.

Table 6.2 - Distance factor and bearing (midwinter, ACT) to determine shadow diagrams

Slope (degrees)	TIME 9am	10	11	12	1	2	3pm	TIME 9am	10	11	12	1	2	3pm
Level	2.8	2.1	1.6	1.5	1.6	2.1	2.8							
Orientation of slope: S								Orientation of slope: SW						
5	3.3	2.5	1.9	1.7	1.9	2.5	3.3	3.7	2.6	1.9	1.6	1.7	2.2	2.8
10	4.2	3.2	2.2	2.2	2.2	3.1	4.2	5.3	3.3	2.2	1.8	1.9	2.3	2.8
15	5.9	4.2	2.7	2.5	2.7	4.2	5.9	11.1	4.8	2.6	2.1	2.0	2.4	2.8
Orientation of slope: W								Orientation of slope: NW						
5	3.3	2.4	1.7	1.5	1.5	1.9	2.4	2.8	2.0	1.5	1.4	1.4	1.8	2.2
10	4.2	2.8	1.8	1.5	1.5	1.7	2.1	2.8	2.0	1.4	1.3	1.3	1.6	1.8
15	5.9	3.2	1.9	1.5	1.4	1.6	1.8	2.8	1.9	1.4	1.2	1.2	1.4	1.6
Orientation of slope: N								Orientation of slope: NE						
5	2.4	1.9	1.4	1.3	1.4	1.9	2.4	2.2	1.8	1.4	1.4	1.5	2.0	2.8
10	2.1	1.6	1.3	1.2	1.3	1.6	2.1	1.8	1.6	1.3	1.3	1.4	2.0	2.8
15	1.8	1.4	1.1	1.1	1.1	1.4	1.8	1.6	1.4	1.2	1.2	1.4	1.9	2.8
Orientation of slope: E								Orientation of slope: SE						
5	2.4	1.9	1.5	1.5	1.7	2.4	3.3	2.8	2.2	1.7	1.6	1.9	2.6	3.7
10	2.1	1.7	1.5	1.5	1.8	2.8	4.2	2.8	2.3	1.9	1.8	2.2	3.3	5.3
15	1.8	1.6	1.4	1.5	1.9	3.2	5.9	2.8	2.4	2.0	2.1	2.6	4.8	11.1

Bearing (Angle from North)

Time	9am	10am	11am	12noon	1pm	2pm	3pm
Angle	43°E	32°E	17°E	2°E	15°W	30°W	42°W

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Figure 6.3 - Example of determining the shadow diagram of a building

Question
A building of 3.8m height is sited on a 5° north facing slope. What shadow will it cast between 10am and 2pm in mid-winter?

Answer
The height of the building at each corner is multiplied by the distance factor from table 6.2 for the given slope and orientation to give the length of the shadows cast by each corner.

The distance factors for a 5 degree N slope (from table 6.2) are:

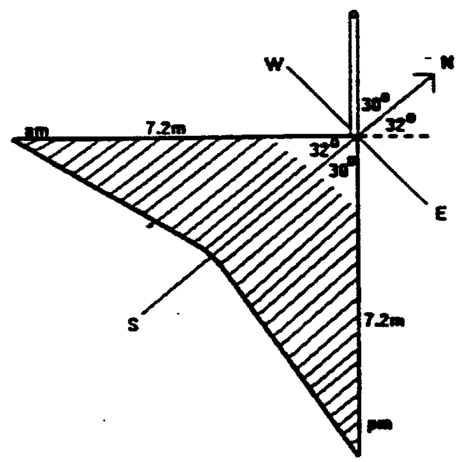
10am	1.9
12 noon	1.3
2pm	1.9

Multiply these factors by the height of the building corner (3.8m) and determine the bearing of the shadows:

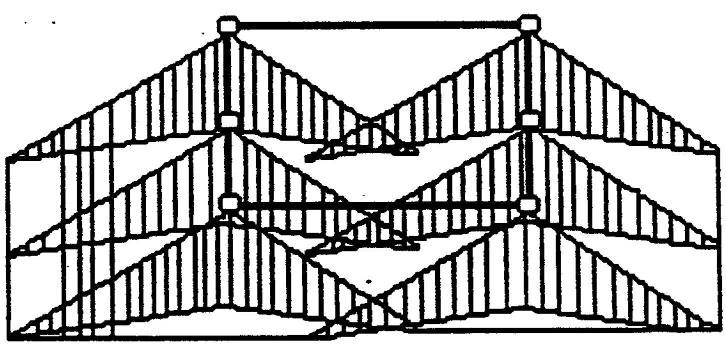
10am 1.9 * 3.8 = 7.2m (32° E of north)

noon 1.3 * 3.8 = 4.9m (2° E of north)

2pm 1.9 * 3.8 = 7.2m (30° W of north)



Repeat this procedure for each corner to build up a composite diagram of the building's shadow.



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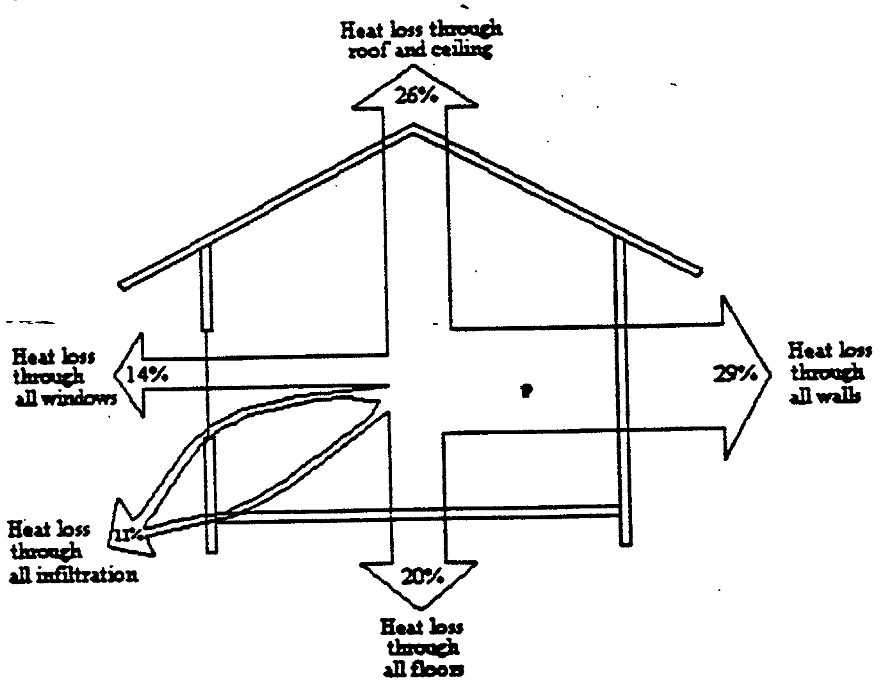
6.2 Insulation

Insulation reduces the amount of heat entering the house in the summer, and leaving the house in winter. This reduces the amount of energy needed to heat and cool a dwelling. Any heating inputs into a dwelling, either through direct solar radiation or a heating device, should be retained within the dwelling as long as possible to lessen the need for further heating. Heat can be lost from the inside of a dwelling to the outside by conduction and radiation through walls, ceilings and floors. The proportion of heat loss through various paths for a typical uninsulated detached brick veneer dwelling in Canberra is shown in Figure 6.4.

Figure 6.4 - Heat loss for houses



The amount of heat loss through solid elements is a function of the insulation value of that element, the area of that element and the difference between inside and outside temperatures. Thus the area as well as the thermal transmittance is important in considering heat loss. Although glass is not as good an insulator as brick veneer, the solid walls have a much greater heat loss because they are much greater in area than the windows in an average house.

Most traditional construction materials have low insulation values thus additional insulation material is usually necessary to be installed within the building to reduce heat loss through the building elements.

Insulation is measured in terms of R values, which is a measure of the thermal resistance of an element of the building. The higher the R value, the greater the resistance to heat flow and thus a better insulator. The R value can be the combined insulation value of all materials in a building section plus air spaces, or it can be the insulation value of a particular material.

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Recommended insulation requirements for the ACT have been calculated according to the local climate and are as follows:

- ceilings - minimum R value of 3.4
- walls - minimum R value of 1.7
- floors - minimum R value of 1.0

A range of insulation materials and building techniques could be used to achieve these values. Table 6.3 gives examples of R values for common elements.

Bulk insulation and reflective insulation are the two main types of insulation. Bulk insulation is a poor conductor of heat and therefore restricts heat from passing through. The main materials used for bulk insulation are mineral wools such as rockwool and glass fibre, foamed plastics such as polystyrene, polyurethane and urea formaldehyde, and cellulose fibre.

In analysing the properties that govern the R value it is important to note that the thickness of the material is not as important as the density. The lighter the material the more likely that it will be a poor conductor of heat. Also, trapped air spaces are important insulation aids, either within materials such as timber or in spaces between materials such as brick veneer walls.

Reflective insulation needs an adjacent air space to function properly. It reduces heat flow by reflecting back most of the radiation on the warm side, and/or by not emitting much radiation on the cool side. This form of insulation is more effective in limiting heat gain in summer than limiting heat loss in winter. Reflective insulation does not provide enough insulation for ceilings on its own. It should be supplemented with bulk insulation.

6.3 Thermal mass

Insulation will prevent the loss of heat that is already inside the dwelling, but it does not store heat, eg overnight or during cloudy periods. Some building materials have the ability to absorb and store heat, such as concrete, clay bricks, stone and ceramics, and are referred to as thermal mass. These materials will absorb heat from solar radiation that strikes them or from the heated air around them and radiate out this heat during cooler periods. This evens out the temperature range within the building.

The general rule in solar passive house design is to maximise the amount of thermal mass within the dwelling, in addition to insulation. This is most commonly achieved by designing the dwelling with a concrete slab floor and cavity brick or reverse-brick veneer walls. Conventional brick veneer walls store negligible amounts of heat as the brickwork is on the outside face of the building rather than the inside. However when combined with a concrete slab floor and adequate insulation in the walls it forms an acceptable building element. In addition, the incorporation of some internal brick walls, eg a brick fireplace or feature walls, within a brick veneer house will contribute some thermal mass.

Concrete slab floors should be insulated around the edge of the slab to prevent heat loss to the surrounding ground. The ground under the slab maintains a fairly constant temperature throughout the year so there is no value in insulating under the entire slab.
For greatest thermal benefit the slab should be finished with ceramic, quarry or slate tiles rather than carpet or vinyl sheeting as the tiles will allow heat to penetrate into the slab

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whereas other surfaces inhibit this flow. As a compromise, areas of the slab that receive direct sunlight, eg next to windows, should at least be tiled with the rest of the slab finished in other materials.

Table 6.3 - R values for common building elements

DESCRIPTION OF ELEMENT	R VALUE
Roofs or Ceilings	
Tiled pitched roof, R 3.5 bulk insulation between ceiling joists, lined ceiling	R 3.4
Tiled pitched roof, foil sarking over rafters, R 3.5 bulk insulation between ceiling joists, lined ceiling	R 3.7
metal deck roof, foil sarking, 20mm air gap, R 3.5 bulk insulation installed between joist/beams, ceiling lining on underside of joists/beams	R 3.7
External Walls	
Brick/masonry veneer with double sided reflective foil laminate fixed to external face of studs, lined internally	R 1.3
Brick/masonry veneer with R 1.5 bulk insulation between the studs, lined internally	R 1.7
Brick/masonry veneer with R 1.0 foam board fixed over the face of the studs, lined internally	R 1.7
Weatherboard/fibre cement. double sided reflective foil laminate dished between studs, lined internally	R 1.3
Weatherboard/fibre cement cladding, R 1.5 insulation between studs, lined internally	R 1.7
Cavity brick with R 1.0 foam board in cavity	R 1.7
Floors	
Concrete/masonry on ground	R 1.5
Timber framed floor open around perimeter	R 0.4
Timber framed floor, enclosed perimeter, reflective foil laminate, dished between joists	R 1.0

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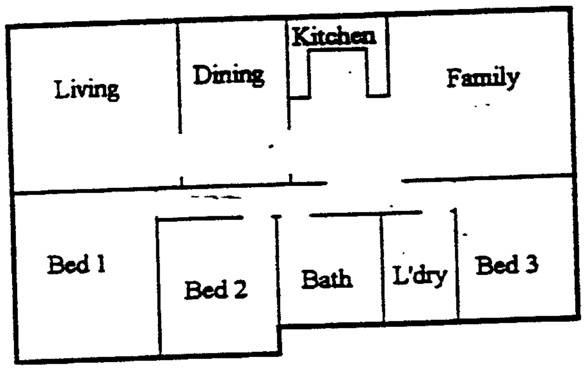
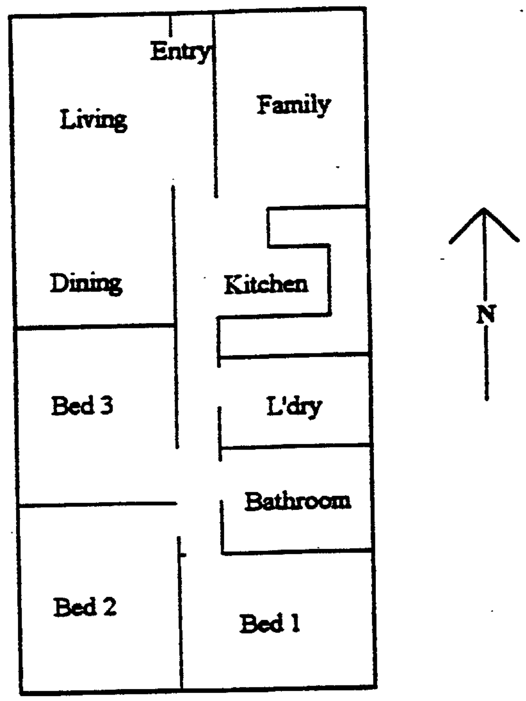
6.4 Building Design

Room layout

For energy efficiency it is preferable to divide a dwelling into separate zones according to the different thermal comfort requirements of different activity spaces within the dwelling. Ideally living areas that are constantly in use should be placed on the sunlit northern side of the house where they will receive the most solar heating during winter. Sleeping areas, bathrooms and laundries which are unused for most of the day may be placed on the cooler southern side (see figure 6.5).

Figure 6.5 - examples of room layouts





Windows

Windows are a critical element in passive solar house design as they determine the amount of solar energy that will enter the building. The general principle is to maximise the window area on the northern side of the dwelling, have minimal window areas on the eastern and southern sides and none on the western side. This will maximise heat gain in winter, and minimise heat gain in summer. As a general rule, the area of north-facing windows should total 15%-20% of the building's floor area.

Ideally, north-facing windows should be full height to allow full sun access in winter. Some east and west facing windows may be desirable to catch the early morning or late afternoon sun, but care must be taken to avoid overheating through these windows in summer.

In summer it is desirable that no direct solar radiation enter the building through the windows. It is thus important that adequate shading is provided over the windows. This can be achieved by designing eaves which are wide enough to shade glazing in summer or by building pergolas over window areas on which deciduous plants can be grown or on which removable shading material can be placed.

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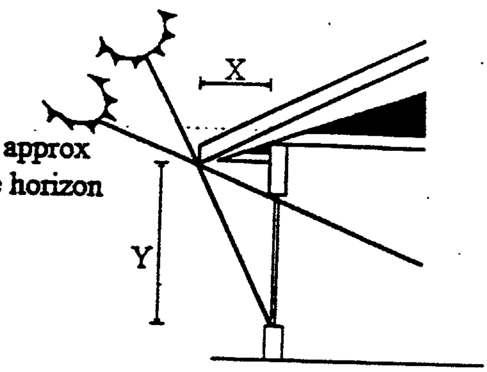
Adjustable shading devices such as awnings, shutters and pergolas with deciduous creepers are always to be preferred to fixed shading. Fixed shading that keeps out unwanted summer sunlight may also keep out some winter sunlight unless carefully designed.

To calculate the ideal projection of a fixed overhang on a north-facing wall to provide shading of windows from October to February, use the formula: $x = 0.45y$

x = eaves overhang
y = vertical distance from window sill to overhang
0.45 = sun angle factor



Shading of east and west facing walls is more difficult as the sun is lower in the sky at the time when these windows are directly exposed to sunlight. Shading devices ideally need to be placed vertically in front of the window to block the sunlight, eg pull-down awnings.

In order to prevent the sun's heat trapped behind the glass being lost back out through the glass when the sun is no longer shining, a system of window insulation is necessary. The most common form is curtains, but they must be of heavy, closely woven material with a backing to be effective in reducing heat loss. The use of a backing creates an insulating air space between the curtain and the backing for greater effectiveness. It is also important to enclose the top of the curtain with a pelmet to prevent room air passing over the top of the curtain and down across the cold window and thus losing its heat.

Double glazed windows are also effective in preventing heat loss through the provision of a fixed insulating air space between the window panes. It is important however that the glazing be adequately sealed to prevent condensation forming between the panes during winter.

6.5 Landscaping

The placing of trees, shrubs and other plants around a dwelling can have a beneficial effect on the microclimate as well as the energy requirements of the house. Unfortunately there is a conflict of interest between Landscaping and the provision of Solar Access. When planted on the northern side of a dwelling, trees deciduous or evergreen can interfere with winter solar access.

Deciduous trees, shrubs and vines may best be used on the northern side of the dwelling to allow maximum winter sun penetration and block summer sun. There are very few native species of tree that are deciduous, this provides the landscaper with another conflict, that of creating native versus exotic gardens. Depending on species a leafless deciduous trees may still block up to 50% of winter sun penetration so when landscaping it is important to avoid shading the northern facade with either deciduous or evergreen trees and shrubs, (refer to the methods for determining setback distances for solar access as described in section 6.1, although in this case the likely height of the vegetation should be substituted for the height

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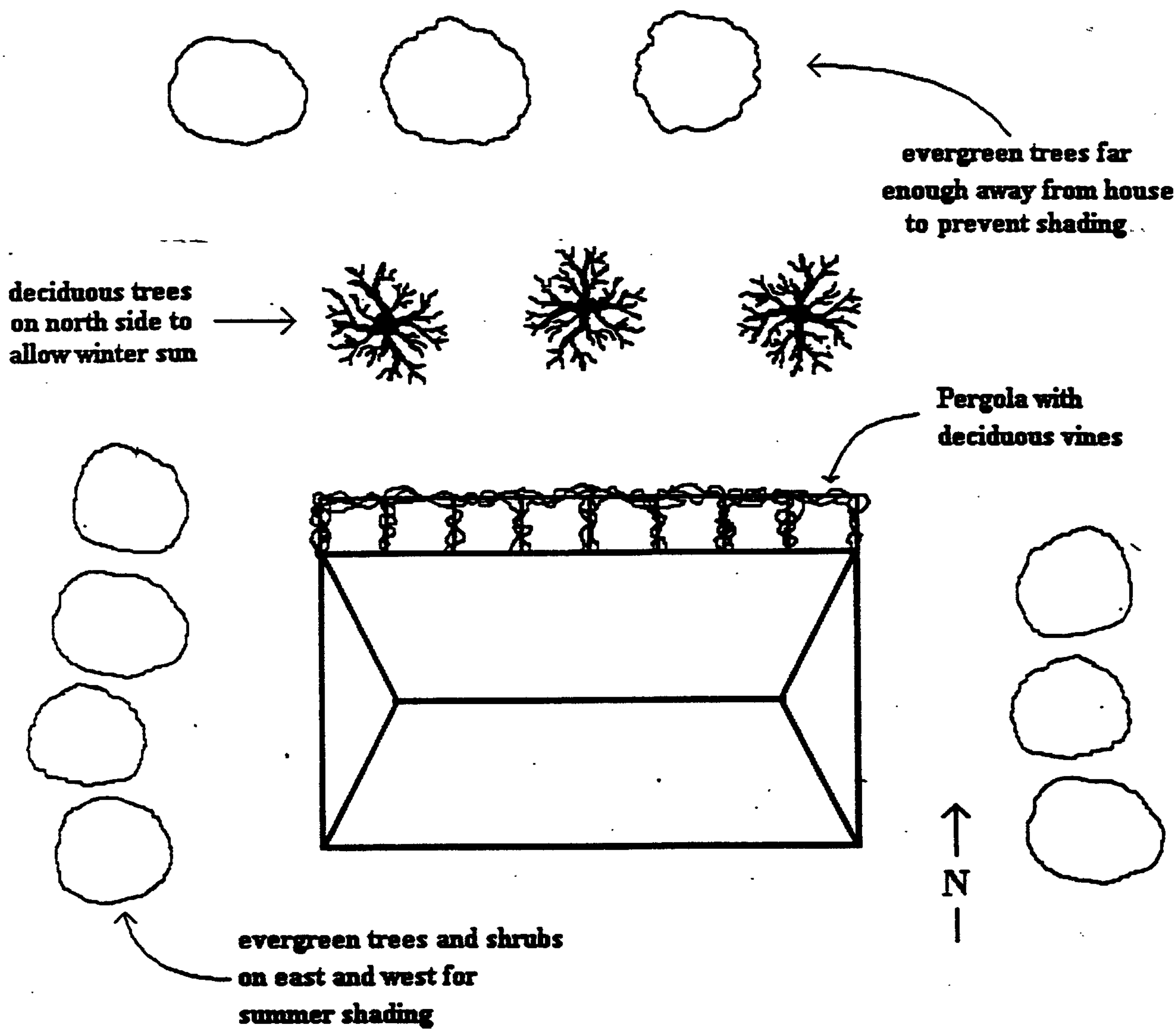
of the adjacent building). This will determine how close vegetation can be to the northern facade to avoid shading between 9am and 3pm. However, evergreen trees and shrubs on the western and eastern sides of the dwelling are desirable to block summer sun. Figure 6.6 illustrates these landscaping principles

Whatever tree and shrub planting is planned, it is important that consideration be given to the amount of shading likely to fall on neigbouring blocks when the trees and shrubs are fully grown. Shading of the north-wall of an adjacent dwelling should be avoided wherever possible.

Figure 6.6 - landscaping for solar access



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6.6 Energy efficiency value of furnishings and other fittings

To facilitate the public assessing the energy implications of different furnishings and fittings, the following is a list of factors that may add or detract from the energy efficiency of a house.

Furnishings & Fittings

- In the case of timber flooring:
  - provision of thick floor coverings such as carpet and underlay, or cork or ceramic tiles
- Heavy, tight-fitting curtains to all glazing in living and sleeping areas, or double-glazing.
- Pelmets over curtained glazing in living and sleeping areas.
- Skylights or roof not double-glazed.
- Skylights or roof glazing not effectively shaded during summer.
- Draft seals around external doors and windows and sealing between door and window frames and wall.
- Draft seals around internal doors to rooms with fixed ventilation, such as bathrooms, toilets, and ensuites.
- Exhaust fans, ventilators and fireplaces have dampers or shutters.
- Compact fluorescent lights in at least living and sleeping areas.
- Water heater -
  - solar
  - gas

When calculating the energy rating of a house, 10 points should automatically be added to take into account furnishings and fittings.

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