PART A

A Summary of Design Guidelines

Good design and energy efficiency

A1 - House Siting and Access to the Sun

The Sun

Good access to the sun is the prime ingredient in an energy efficient house. It is important to understand that the sun's path changes throughout the year:

- in the summer the sun rises south of east and sets south of west (Figure A1.1)

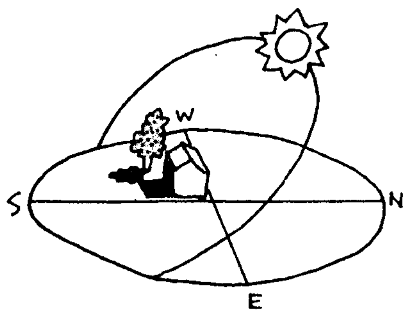


Figure A1.1: Summer sun movement

- in the winter the sun rises north of east and sets north of west (Figure A1.2)

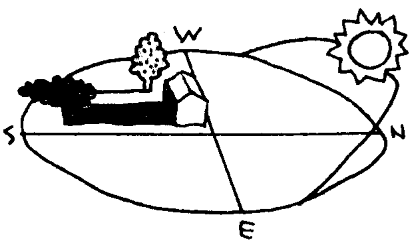


Figure A1.2: Winter sun movement

Building Orientation

Proper building orientation enables the house to receive winter sunshine and to block out unwanted heat. For this reason, correct siting and orientation (Figure A1.3) of a new house is a fundamental design decision.

Facing the living areas towards the north is the ideal aspect for a new house.

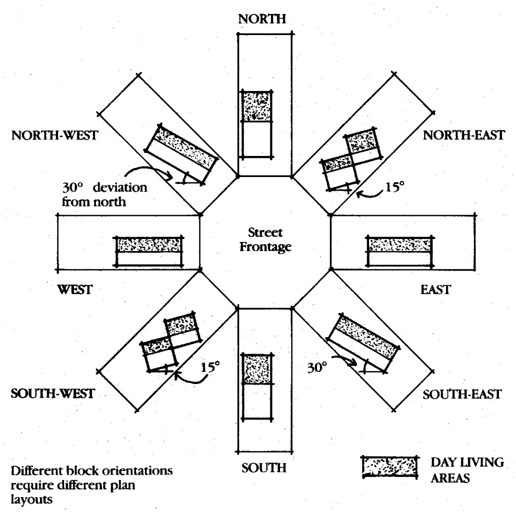


Figure A1.3: Building orientation for solar access

Lots at Perradenya have dimensions that allow adequate solar access, and are able to take into account likely house size and the relationship of each lot to the street.

When deciding the site for a new house, care must be taken to allow adequate distance from obstructions to the north, such as tall trees, to avoid any possible interference with access to the sun. A good rule of thumb is to set the house back at least 1.3 x the height of the northern obstruction

(Figure A1.4). (A greater distance is desirable to allow the entry of diffuse light in winter.)

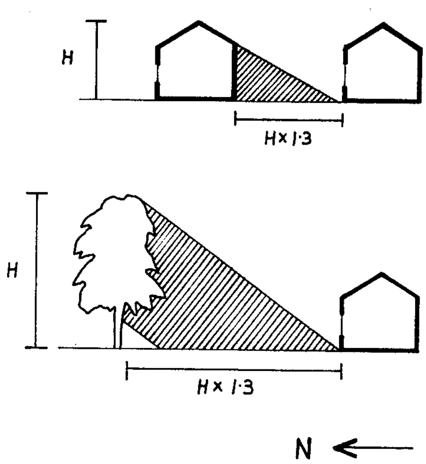


Figure A1.4: Distance from northern obstructions

Internal Planning

The location of the living, sleeping and service areas of the house should be carefully considered and arranged in such a way that takes advantage of the northern aspect, while lessening the impact of winter winds and harsh western sun (Figure A1.5).

- face daytime living areas to the north for optimum energy savings
- avoid a westerly aspect for bedrooms unless they can be adequately shaded; east or north is preferable, with south being cooler all year round
- place utility areas such as bathrooms, toilets and laundries as buffer zones to the west or south
- where possible locate covered car parking on the west or south sides to protect the rest of the house from summer sun and winter winds
- on lots where the land orientation is east-west, place the house close to the southern boundary to maximise north solar access and separation from houses to the north
- create zones by grouping rooms with similar uses and heating needs, eg. living zone, sleeping zone, service zone and separate these where possible by doors to aid winter heating
- use doors at the top or bottom of stairwells to prevent losing heated air to the upper floor, and avoid open stairways in heated areas
- avoid ceilings more than 4m in height to reduce the volume to be heated
- group hot water using areas together to reduce pipe length and consequent heat loss and hot water wastage

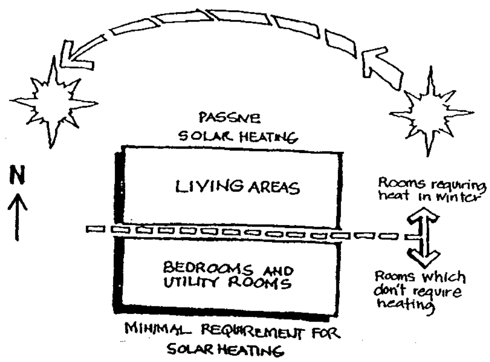


Figure A1.5: Internal Planning

A2 - Windows and Natural Light

Windows are an important part of a home, letting in natural light, allowing views and providing fresh air access. Well planned and well protected windows improve comfort year round and reduce the need for heating in winter and cooling in summer.

Window size, orientation, shading and coverings can have a significant impact on energy efficiency and comfort.

Position at least half of total glazing in your house north or east side. Avoid west facing glazed areas unless they are well shaded.

Designing north windows for maximum winter solar access can reduce heating bills by up to 25%. External shading can block up to 75% of summer heat gains.

Window design

The main principles of energy-saving window design are:

- maximise winter heat gain by orienting windows to the north
- minimise winter heat loss through appropriate window sizing, double glazing or by using protective internal window coverings such as heavy curtains with pelmets
- minimise summer heat gain by protecting windows with external shading devices and through appropriate sizing and positioning of windows
- consider raising sill heights for windows in south or east facing rooms, particularly for bedrooms and studies, as much heat is lost through large glass areas that are shaded

Window shading

- for maximum control, and versatility, use adjustable shading devices such as louvres and removable shadecloth over pergolas, or planting such as deciduous trees and vines
- use fixed horizontal shading such as eaves, awnings and battens over pergolas
- the width of the overhang should be enough to eliminate summer sun but not so wide as to prevent winter sun access
- it is best to extend horizontal shading past the edges of the window for at least the width of the shading device

Sun Angles during the year

At noon on the following dates in Lismore, the sun is at an approximate angle above the horizon of:

22 Jun 39°; 22 Mar/Sep 62°; 22 Dec 85°

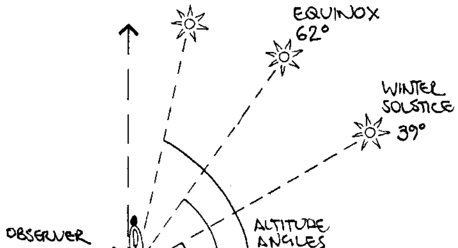


Figure A2.1: Sun angles during the year

A3 - Breezes and Ventilation

The control of air movement - by allowing maximum ventilation in summer and containing heat in winter - is an important component of energy efficient housing design. It is fundamental to consider where breezes come from and to place rooms in the house to best use the available breeze. Also carefully consider window positions in each room.

Ventilation

Two types of ventilation should be considered: stack ventilation and cross ventilation.

Stack Ventilation

The natural tendency of warm air to rise, to escape through an opening in the roof or high up on a wall and to be replaced by fresh air which enters through lower openings, assists in cooling buildings.

Clerestory windows provide this form of ventilation. The air velocity achieved by such natural convection is usually not enough to provide a cooling effect for our bodies but it is useful as a way of expelling the build-up of warm air inside the house. A cowl or wind driven extractor fan increases airflow in stack ventilation.

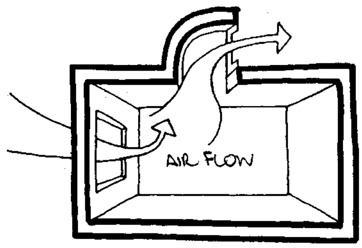


Figure A3.1: Stack ventilation

Cross Ventilation

For airflow to have a cooling effect on our bodies, greater air speed is needed. This is particularly important in warm and hot, humid conditions, where air movement over the body provides a sensation of coolness by evaporating perspiration from the skin.

Cross ventilation occurs more efficiently through a room with openings in opposite walls. Using larger windows on the leeward side than the windward side of the house inceases the air flow speed. Efficient cross ventilation reduces when the depth of rooms to be ventilated is deeper than six metres.

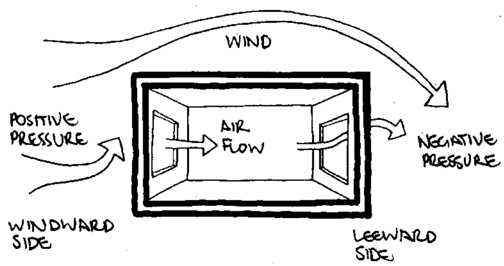


Figure A3.2 Cross Ventilation

Heat Retention in Winter

Also important when considering breezes and ventilation is how to retain heat in winter. This can be accomplished by keeping the following points in mind at the design stage of your house:

- provide adequate draught sealing by installing weatherseals and draught excluders to all external doors and windows, and to doors leading to unheated areas
- install automatic door closers to external doors and doors leading to unheated areas
- provide dampers to open fireplaces
- avoid vented recessed light fittings, fixed wall vents, cavity sliding doors and permanently vented skylights
- fit exhaust fans with self closing dampers if they are in heated areas
- vent rangehoods and exhaust fans directly outside and not into the roof space
- seal well around construction joints, skirting boards, plumbing pipes, exposed rafters and beams, inbuilt heaters, air conditioners and between masonry and other building materials
- provide a separate external air supply to heaters which burn internal air, ensuring it can be closed off when not in use
- as timber floors in stumped houses are an area of heat loss, consider using a skirting around the outside of the house with controllable vents to retain heat under the floor in winter, and to allow ventilation in summer

A4 - Heat Absorbing Building Materials

Thermal mass

Heavy materials such as brick, solid concrete, stone and earth take a long time to heat up and a long time to cool down. They are said to have high **thermal mass**. Lightweight materials do not hold heat and have low thermal mass. Thermal mass can be used effectively to stabilise summer/winter temperatures, particularly where day and night temperatures vary widely.

In summer, shaded concrete floors and masonry walls absorb heat during the day, lowering the ambient room temperature. This heat is released at night and removed by ventilation.

In winter, concrete walls and floors can absorb heat directly from the sun during the day, gradually releasing heat in the evening as the air temperature drops, so that rooms remain warm (Figure A4.1).

Heating and cooling using thermal mass

To maximise the effect of thermal mass in summer and winter:

- locate masonry floors and walls where they can receive direct winter sun to maximise winter heat gains yet be shaded in summer
- give priority to using thermal mass in north facing rooms, particularly where winter heat gain is sought. As the area of north facing window increases, the more internal thermal mass is required to maintain a stable temperature
- locate thermal mass throughout the house for summer comfort, particularly in north, west and east facing rooms that may become hot, as the thermal mass will soak up excess heat; (where thermal mass is used in west facing rooms, shading of windows to exclude the sun is critical)
- masonry fireplaces are best located on internal rather than external walls so that the chimney can radiate additional heat into the house in all directions
- insulate thermal mass from external temperatures for maximum effectiveness, eg, reverse brick veneer with the insulated wall externally of the thermal mass

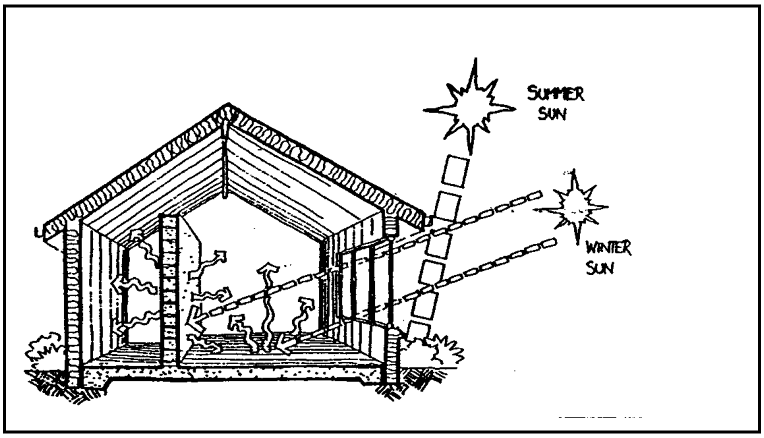


Figure A4.1: Thermal mass principles

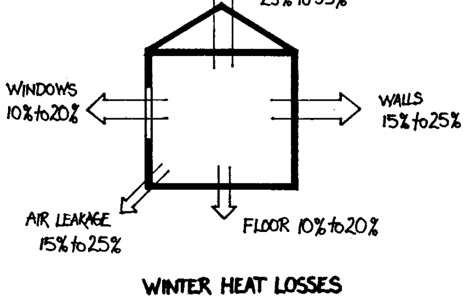
A5 - Insulation

Insulation is important because it reduces the flow of heat into the house in summer and out of the house in winter. Insulation does not absorb and store heat as heavy construction materials do (thermal mass), it simply makes it harder for the heat to pass through the walls, floor and ceiling.

There are, broadly speaking, two type of insulation materials: bulk and reflective. Bulk insulation provides resistance to heat flow and comes in the form of batts, blankets, board and loose fill. Reflective insulation reduces the radiant heat transfer across an enclosed space and comes in foil sheets, batts and panels.

Select insulation materials for the particular situation for which they are required: whether for walls, floor, roof or ceiling. Various manufacturers publish information on selecting and using their materials.

Figure A5.1 shows the major winter heat loss and summer gain is through the roof and ceiling. Give special attention to these building elements.



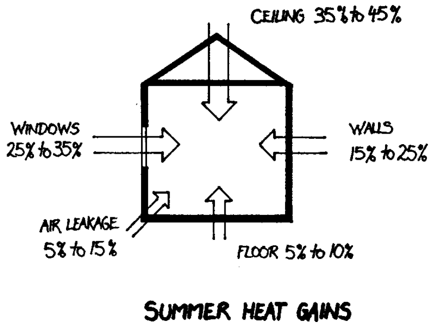


Figure A5.1: Heat Flows without Insulation (approximate gains and losses)

Principles of using insulation

Insulation is rated by an R value, which is its resistance to the flow of heat. The higher the R value the greater the resistance. However, this is only true to a point, as installing insulation greater than recommended R Values gives a reducing level of additional performance.

The following principles are essential for effective performance:

- avoid gaps in insulation
- do not compress bulk insulation
- allow clearance around chimneys and light fittings to avoid overheating
- protect insulation from contact with moisture
- provide a sealed air space with reflective insulation for optimum effectiveness
- provide vapour and moisture barriers to prevent condensation
- install more than the mandatory levels for greater energy efficiency and comfort

Recommended insulation tips

- install R2.5 ceiling insulation
- install R1.0 external wall insulation and/or reflective foil in timber frame and brick veneer walls
- use a skirting around the outside of a stumped house with controllable vents to allow air access in summer and reduce heat loss
- consider substituting solid external masonry walls with materials such as aerated concrete blocks that have higher insulation levels, thereby avoiding the need for additional insulation
- provide reflective foil to the underside of roofing material to reduce the radiant heat load and add recommended ceiling insulation
- give preference to light coloured roofs as dark roofs greatly increase summer heat gains

A6 - Water Efficiency

As populations increase, more and more strain is being placed on existing water supplies. Current Australian water usage levels are not ecologically sustainable. The management and effective use of water is therefore more crucial than ever. Considering the fundamental importance water plays in our lives, we all have a stake in the efficient use of this valuable resource.

Rous Water's Strategy

Rous Water is committed to effective water cycle management. The importance of efficient water usage is emphasised through various demand management programs

At Perradenya, Rous Water demonstrates the technology of an additional water source: reclaimed water for household purposes. Over half of the water supplied to urban areas generally ends up as wastewater. Wastewater is also the only source of supply that increases with population, therefore it makes sense to reclaim and recycle this resource. Rous Water's objective is to showcase a state of the art water recycling facility and produce the highest quality recycled water, offering various options to houseowners to use recycled water in combination with town and rain water.

Water Efficiency

Efficient water use saves you money and saves the environmental cost of building new dams or treatment plants. There are numerous options for more efficient water usage, including the following:

- monitor your water meter: know how much water you use
- use a dual flush toilet: the 6/3 litre dual flush toilet reduces the average household's use by over 35,000 litres of water a year
- install water efficient shower heads: they use 2-5 times less water than regular shower heads and save water heating energy too
- look for the AAA water efficiency rating when buying appliances for the bathroom, laundry or kitchen
- use tap flow regulators: they can be built into hand basin and kitchen tap spouts
- minimise the amount of lawn in your garden by planting water wise shrubs or native grasses. Where lawn is grown, maintain it at around 5+ cms to reduce evaporation
- use a xeriscape garden design (see **Landscaping**)
- install an underground drip irrigation system for watering the garden. A dripper system uses much less water than a sprinkler, and still effectively waters the garden

Further information can be obtained directly from Rous Water, PO Box 230, Lismore NSW 2480; tel: 1300 132 446, fax: 02 6622 1181, the website at www.perradenya.com.au; or email water@rouscc.nsw.gov.au

A7 - Hot Water, Lighting and Appliances

General

Housing designed on energy efficient principles will require 40% of the heating and cooling energy needed by an average home to maintain a comfortable living environment.

More savings can be achieved by using energy efficient lighting, appliances and, most importantly, hot water systems. The time to maximise the energy efficiency of a home is at the design stage.

Hot Water Systems

Around 95% of electricity generated in NSW comes from burning coal, which causes air pollution and atmospheric warming. As hot water accounts for up to 50% of a household's energy costs, it's important to think carefully before selecting your hot water system. Choosing the most appropriate system for your needs and careful choice of fuel can considerably lower your hot water costs and provide environmental benefits.

While solar hot water systems and heat pumps (which work like a refrigerator in reverse) cost more to purchase, they can reduce your water heating energy bill and greenhouse gas pollution by up to 70%. In NSW, a solar hot water heater will provide approximately 65-80% of your hot water free of charge. Heat pumps are a highly efficient form of water heating which use around 70% less electricity than other electric water heaters.

Hot water systems are usually either storage or instantaneous types, and can run on solar energy, off-peak electricity or gas.

STORAGE HEATERS

- store and heat water, usually at night for use the following day
- run most economically on solar energy, which is free, or off-peak electricity, which is currently cheap but may increase with higher tariffs

INSTANTANEOUS HEATERS

- usually run on natural gas or LPG
- heat water as required and do not store it, so cannot 'run out'
- are smaller than storage systems and can be installed internally (gas systems must have a flue)
- are connected to the mains water supply and deliver hot water at a slightly reduced pressure
- sometimes have electronic remote controls for precise temperature control from inside the house

Lighting

Choosing a house design that maximises the availability of natural light without creating major heat gain or heat loss is important. Artificial lighting should not be necessary for general activities in a room during daylight hours.

Table A7.1 gives recommended lighting types for different areas and activities.

Room	Lighting type	Incandescent	Quartz halogen	Tubular fluorescent	Compact fluorescent	Solar
Kitchen	g	a		r	r	
	t	a	r			
Living room	g	a			r	
	t		a		r	
Dining room	g	a	a		r	
	t	a	r		a	
Study	g	a			r	
	t		a		r	
Master bedroom	g	r			r	
	t	r	a		r	
Children's bedrooms	g				r	
	t	r	a		a	
Laundry	g	a		r		
	t	a	r		a	
Hallway	g	a			r	
	t	a	r		a	
Bathroom	g	a		r		
	t	r	r			
Outdoor feature	g		r		a	r
Security - constant	t			a	r	r
Security - motion detection	t	r	a			

g = general; t = task;

r = recommended lighting source

a = alternative lighting source

Table A7.1: Recommended lighting types for different areas and activities

Save future energy costs at the design stage of your house by carefully considering the purpose of each room and choosing light fittings and lamps accordingly. Light rooms according to their purpose: for example, a kitchen or family room requires an even spread of bright lighting, while others such as living rooms require a mix of general and task lighting options. The layout of energy efficient lamps, fittings and switches in such rooms should allow several possibilities for lighting the room.

Appliances

Appliances, like light fittings, should fit their purpose. When choosing appliances ensure that output is not too large or too small for household needs as this reduces appliance efficiency. Select the most energy efficient services and appliances without compromising your expectations.

Appliances such as space heaters and hot water services, air conditioners, refrigerators, freezers and most major appliances have energy rating labels which enable their energy efficiency to be compared. A minimum 4-star rating is recommended.

When comparing appliances, consider the initial cost and the ongoing running costs over the life of the system, as well as the greenhouse gas impact of the various fuel sources.

Other Services

Wherever possible select services and appliances which have flexibility of control, enabling the most energy efficient setting for the task to be selected. For example, a variety of hotplate sizes, variable temperature settings and/or variable water control settings make washing and cooking more energy efficient.

Consider the optimum location of services at the design stage of your house. Locate services near the most frequently used outlets for maximum efficiency with minimum heat loss through ducts and/or pipes.

Most importantly, remember that energy efficiency is always interactive with user behaviour. Encourage energy efficient behaviour, such as closing off heated areas, setting thermostats and turning off unneeded lights.

A8 - Landscaping

Landscaping is an easy and inexpensive way to improve the energy and water efficiency of a house, enhance the appearance and value of your property and provide screening for privacy.

It is important to select types of planting and strategically position them to protect your house from the harsh extremes of summer sun and chilling winter winds. In doing so, you can enhance both your house's internal and external comfort and reduce the need for supplementary heating and cooling.

The key aspects of energy and water efficient landscaping are:

- keep the area in front of north facing windows clear of tall obstructions such as evergreen trees, unless they are far enough away from the house (refer to Part A1)
- shade west and east windows and walls in summer with deciduous vines, trees and shrubs
- plant dense windbreaks on sites exposed to high winds as protection from cold winter winds from the south and west
- plant low shrubs and create lawns and ponds to help cool summer breezes
- consider using south facing courtyards with moist cool ferneries or pools to assist summer cooling
- avoid paving directly in front of north facing windows unless summer shading is provided to the paved area
- use ground covers such as grass and shrubs close to the building to cool the air and reduce reflected heat
- use a dripper irrigiation system to deliver water to plants most efficiently

Xeriscape gardens

Since half of domestic water is used on gardens, pools and lawns, consider using a Xeriscape garden design which conserves water and can be used in conjunction with other energy efficient landscaping principles.

Consider consulting an appropriately qualified landscape architect or designer. Alternatively, refer to the resources section at the back of this Manual for further contacts.

A9 - Energy Rating

NatHERS energy ratings

NatHERS is a computer software based house energy rating tool which may be used by an accredited HER assessor to determine the house energy rating of all dwelling types

House energy ratings enable the energy efficiency of houses to be assessed and comparisons of energy efficiency to be made between houses. They provide a basis for improving the energy efficiency of housing design and can be used, at the design stage, to determine the lowest cost method of complying with energy efficiency regulations and policies.

A house energy rating is represented by a scale from 0 to 5 with a rating of 0 stars signifying a poorly performing building envelope and a rating of 5 stars signifying a highly efficient building envelope.

The software performs hourly calculations for the heating and cooling of a house over the period of a year. This is based on specific information including the house design, dimensions, construction materials, orientation and post code/climate zone for a standardised occupant pattern. The results (in megajoules of energy per square metre of floor area per year) are an estimate of the energy required to maintain a house at a range of set temperatures.

The following information is required to complete a house energy rating using NatHERS:

- drafted dimensioned plans, sections and elevations of the house, including site plant showing orientation and neighbouring structures and large trees. The scale can vary, however 1:100 is preferred
- indication of wall, ceiling and floor insulation
- indication of internal and external window coverings for shading devices and floor coverings
- indication of colour of external walls and roofs

Ideally, those seeking development approval should contact an accredited HER assessor at the house design concept stage. It is at this stage that the assessor can be very useful to an architect, designer and/or home owner and maximise the opportunity to achieve a high star-rating, energy efficient house.

The cost ranges between approximately $100 to $200 depending on the complexity of the house design and the number of changes needed. The exact cost will be determined by the design of the house.

See Part C of this Manual for contact details for accredited HER assessors.

A10 - Building Materials

Building covenants

The building covenants at Perradenya require that the materials used to construct a house are:

- brick, brick veneer
- stone
- concrete
- timber
- glass
- or any combination of these

Within these groups of materials, and their related products, there is a wide choice of materials that can be used in building a house. While some aspects of the house will require materials of a certain type, the materials selected should be considered within the wider framework of environmental impact and ecological sustainability.

Ecologically sustainable materials

The assessment of materials for ecological sustainability considers a wide range of issues involved in the production and life cycle of the material. These are, broadly:

- resource depletion
- embodied energy
- inherent pollution

There are systems in place, discussed in Part B, to assess all building materials for these factors. They cover raw material extraction, processing and manufacturing, transport, construction use and ultimate disposal or recycling.

As a general rule, select materials that are low maintenance, non toxic, long life, renewable ones. Be mindful that some materials, by their production or disposal requirements, are not environmentally friendly.

Preferred materials

When choosing materials give consideration to such factors as where the material comes from, whether its extraction as a resource creates environmental havoc, whether it has been transported a great distance, whether it is recyclable and whether there is a lot of waste in its production and usage.

For example, timber may be of a relatively rare rainforest species or from an old growth or wild forest rather than a plantation. It may not be milled in Australia, but imported from endangered rainforests of Asia or America. Wherever possible choose an Australian platation grown timber.