Better Build Toolkit

NEW HOME GUIDE

Table of Contents

Acknowledgements

The author, H. Jones, and the producers of this publication would like to thank the many people involved with its development. In particular, members of the Indigo Shire Environmental Advisory Committee (Energy & Greenhouse Strategy Group), M. Bartsh, Koregraphics, T. McDonell, K. McDonell, and the staff at Indigo Shire Council. Their knowledge, feedback, enthusiasm and support were integral to the completion of this Guide. We would also like to thank the following community members who supplied or allowed pictures of their homes to feature within the book.

C. Roostey, J. Indian, J. Phillips, R. Baker, M. Charles Jones, B. Hoffmann, A. Pockley, G. Jones, B. Foran, A. Garnet, K. Warne, N. & M. Van Nouhuys, N. Jones, K. Andrews, C. Franks, Alatalo Bros – D. McMillan.

Background

The "Better Build Toolkit" is a series of four Guides designed to inform a range of development in Indigo: residential build, home renovation, commercial development or subdivision. The Guides focus on improved building efficiency by providing information on climate sensitive design and construction elements. The Guides also encourage a healthy living environment by providing information on wise choices in products and materials.

The concept for the toolkit was identified as a priority action within Indigo Shire Council's *Environment Strategy* (2009). Each Guide is intended to encourage innovation and excellence above existing industry standards when developing within our communities. People spend a large proportion of time indoors for reasons of work, life, and play. Accordingly, the focus is on how enhanced comfort levels and reduced running costs can be achieved through better building choices, while caring for the health and wellbeing of the occupants and the environment.

There are a number of trends making improved design and development more attractive. These include:

- increases in energy and water prices
- a growing desire to reduce our environmental footprint
- incentives such as grants, rebates and renewable energy targets
- products such as water tanks, photovoltaic (PV) cells, solar hot water and double glazing being more readily available and affordable

Introduction

The *New Home Guide* presents introductory information for people building a new home. It recognises that decisions you make when building, can affect the comfort and energy efficiency of the home for many years to come. The Guide begins with Part A, which presents a number of design elements. These elements can be applied across a range of different construction methods to improve the buildings performance. Sections on energy, material selection, waste reduction, water management and landscaping are also included to help owners consider healthy product choices and reduce energy and water consumption. Part B features discussion on build styles, where the strengths and weaknesses of various construction techniques and materials are highlighted. A checklist concludes the Guide in Part C and leads readers through a short list of questions to help isolate areas for possible improvement. Links and resources are provided for readers wishing to source further information.

The Guide recognises the growing awareness of climate sensitive design and the impact of ever increasing utility charges. Clever use of materials and energy efficient design does not have to come with a luxury price tag nor be at the sacrifice of style, and should be discussed when considering any new building.

Seek advice from relevant professionals to ensure the best match of products, processes and design elements for your particular location.

Good Building Principles

Regardless of development type or scale, there are a number of environmental design principles to consider when building or renovating:

- Reduce the consumption of resources, particularly non-renewable resources through energy efficient design, incorporating renewable energy, using passive solar heating/cooling techniques, natural ventilation and natural lighting.
- Design for durability, adaptability and resale.
- Avoid potential health hazards by minimising the use of hazardous chemicals, avoiding chemically treated materials and being cautious of electromagnetic radiation.
- Maximise the health, safety and comfort of building users.
- Design to minimise waste and maximise water efficiency.
- Minimise the environmental pollution of air, water and soil.

Glossary

Breathability (Building)	How a structure behaves when exposed to moisture (water in both the liquid and vapour state). A building should not trap moisture, instead it should dry out without compromising the water or air tightness of the structure.
Diurnal Temperature Variation	A meteorological term that relates to the variation between the highs and lows in daily temperature.
Double Glazing	A window or glass panel in a door that uses two panes of glass with a 12-20mm space separation. The space may be filled with air or gas. Double glazing improves window energy efficiency.
Embodied Energy	Consumption of energy during manufacture and transport of a product.
Embodied Water	Water used during manufacture of a product.
Feed in Tariff	Rate paid to producers for feeding renewable energy back into the grid supply.
Geothermal Heating & Cooling	A ground source heat pump and the relatively stable geothermal conditions near the Earth's surface are used for the purposes of heating and cooling.
Glazing	Glassed surfaces such as windows, skylights, and glass panes within doors.
Green Energy	Energy generated from renewable sources.
Grey Water	Wastewater generated from household activities such as bathing, dishwashing and laundry, but excluding the toilet.
Hydronic Boiler	Fluid/water based system used to generate heat which is typically circulated throughout the home through radiators or coils. The system is connected to a variety of fuel sources and can be combined with domestic hot water supply.
IEAC	Indigo Environment Advisory Committee. Section 86 Committee of Management.
LED	Light Emitting Diode. Within this document LEDs relate to the use of this energy efficient technology available in lighting and appliances.
Off Gassing	The release of trapped gasses at normal atmospheric conditions. Referred to in this document when talking about Volatile Organic Compounds and the slow release of organic chemicals into the surrounding environment.
Passive Design	Climate sensitive design that reduces the need for mechanical heating or cooling.
PV	Photovoltaic. Referring to the technology used in solar panels for generating electricity.
RBV	Reverse Brick Veneer. Brick construction method where the brick skin is on the inside of the building to add thermal mass. An external cladding is fitted to the outside of the building and insulation added to the void in between the two skins to protect the brick layer from the external elements. This build style can provide improved use of the bricks' thermal mass properties to reduce heating and cooling requirements when compared to standard brick veneer construction.
Sustainability	In ecological terms it is the ability for biosystems to remain diverse and prolific. For humans it the ability to maintain wellbeing which is generally reflected in the considered and responsible use of the world around us and its natural resources.
SV	Sustainability Victoria. Victorian Government agency.
Task Lighting	Lighting which is focused on a specific area to make the completion of visual tasks easier.
Thermal Mass	Ability of a material to store heat.
VOC	Volatile organic compounds are slowly released at room temperature from the material they are found in. VOCs are numerous and varied and many can be harmful to humans and the environment.
WELS	Water Efficiency Labelling and Standard. Water rating labelling for appliances and products.
Zoning	Referred to in the Guide as the closing off of unoccupied sections of the house to reduce heating and cooling needs.

PART A - Build Elements

"Big decisions before the backhoe starts"

Design

Enhance comfort and cut running costs by designing a home that features passive design and the collection, storage and use of natural energy and water.

Top Tips

1. Get it right the **FIRST** time - incorporating sustainable elements from the outset is easier and cheaper then retro-fitting at a later date.
2. Position the building for passive design.
3. Design floor plan, locate windows and select materials for passive heating and cooling.
4. Install double glazing and use window treatments and protection to reduce heat transfer.
5. Maximise insulation options across the home.
6. Remove sources of draughts.
7. Design for energy efficiency, water efficiency and waste reduction.
8. Reduce building size and remove dead space, while considering adaptive layouts.

Passive Design & Orientation

Passive design takes advantage of local climatic conditions to naturally heat and cool the home. The concept uses the seasonal changes in the sun's path across the sky to heat and cool the building rather than using fuel or electricity. The sun's angle of movement across the sky changes depending on the time of the year. This impacts the level of sunlight that can enter a building, as shown in Figure 1. Homes can be designed to capture the low altitude winter sun for heating while using window protection to block out the higher altitude sun in summer.

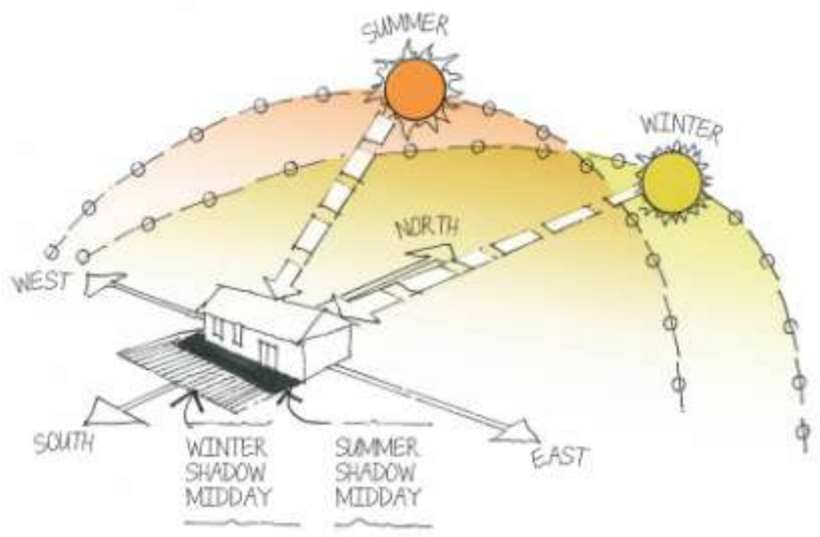


Figure 1: Seasonal change in the angle of sunlight. Design to allow low angle winter sun to penetrate and support winter heating, while excluding the hot summer sun.

Common causes of high energy costs and considerable heat gain or loss may include poor home orientation and oversized or unfavourable window placement. Orientate your house to optimise the sun's ability to heat in winter, provide light as well as support solar hot water and solar electricity generation. In addition, look to capture cooling breezes in summer. Across Indigo Shire a northerly aspect will generally maximise the benefits of the sun. Position living areas to the north and if possible orientate the long axis of the house east – west (see Figure 2).

The shape and orientation of the house block may restrict the amount of rotation available to plan for a north facing home. Block configuration should be considered when purchasing land for future development. Alternatively, the main axis of the house does not always have to face the street.

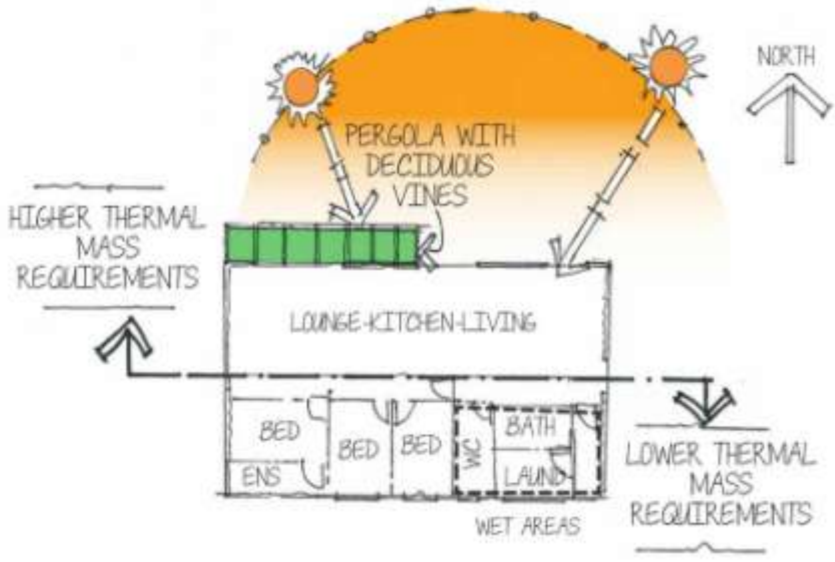


Figure 2: Consider the layout and position of rooms to support solar passive design. Group living areas to the north and sleeping areas to the cooler south side of the building. Consider the placement of garages and utility areas to protect the home from hot western sun.

In general, Indigo Shire experiences cold winters and hot dry summers. However, every location is unique in relation to climatic conditions, orientation, solar movement, wind, and shadowing. The constraints and opportunities of each specific locality should be identified, and then passive design solutions implemented to suit those individual needs.

Passive Solar Heating

Passive solar heating uses lower angled winter sun to heat the home (see Figure 3). Window placement and design, along with thermal mass inside the home, are used to capture and store natural heat from the sun. This stored heat is then released at night when extra heating may be needed.

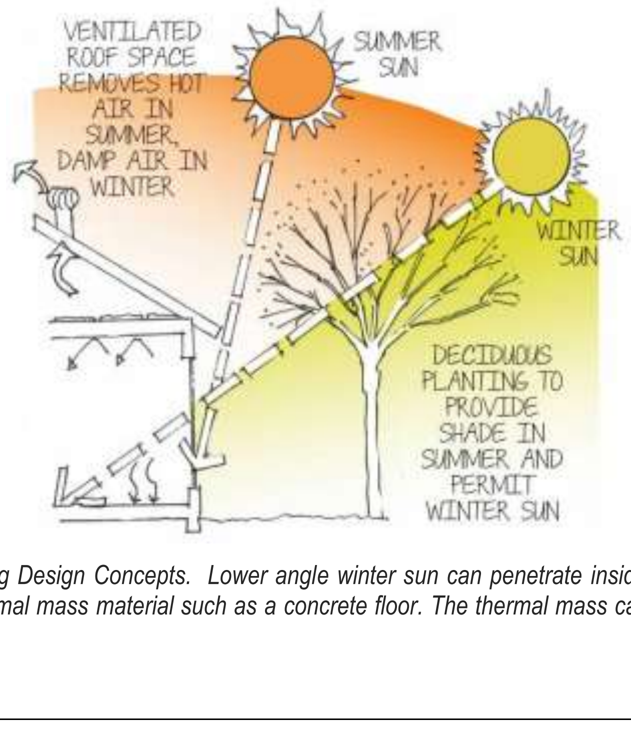


Figure 3: Solar Heating Design Concepts. Lower angle winter sun can penetrate inside the home where heat can be stored in a thermal mass material such as a concrete floor. The thermal mass can later release the heat when it is needed.

Passive solar heating is best achieved with north facing glazing fitted with appropriately sized eaves to block summer sun while allowing low angled winter sun to penetrate. External shading is necessary to protect the generous northern windows from solar heat gain during summer. Windows still require enhanced glazing treatments and protection, such as double glazing and heavy drapes, to limit winter heat loss. Installing quality insulation, draught sealing, and closing down (zoning) the area to be heated also assist passive heating

Passive Cooling

Passive cooling design slows unwanted daytime heat gain and utilises cooling night breezes to remove stored heat from the building. Air movement is the most essential component in passive cooling. Window placement and building orientation should encourage cross ventilation to remove warmer air and heat energy stored in the building's thermal mass during hot weather. Select window designs that allow the maximum opening possible to promote air intake. Styles such as double hung, sliding or casement varieties allow increased air flow compared to awning opening windows.

Consider installing ceiling fans with a summer and winter switch to aid air flow by pushing hot air down in winter and circulating cool air in summer. Avoid the accumulation of hot air in the roof space and house through the use of passive exhaust fans in the ceiling, perforated lining of eaves, "whirly birds" and solar roof fans.

Key elements of passive cooling design include:

- orientate the home and use garden design to encourage cross ventilation
- minimise unwanted heat gain and promote ventilation through smart selection and location of windows
- install fans to provide air movement in the absence of breezes
- externally shade windows during summer to reduce heat gain using options such as eaves, awnings, blinds and shrubs
- use high thermal mass construction materials to absorb heat entering the building in regions with significant diurnal temperature ranges

Additional passive design elements such as installing quality insulation, draught proofing to eliminate air leakage and advanced window design can be used to maximise the benefits passive heating and cooling provide.

Windows – placement, systems, and protection

The location, size and type of window glazing along with the frame material will have a major impact on the energy efficiency of your home. Choose window location wisely and employ shade to limit direct radiant heat entering the house during summer. Refer to Table 1 for a basic guide to window installations.

Table 1: Basic guide to window placement for passive solar heating

North	Maximise north facing windows to support passive design, especially in living areas. In summer use flexible shading such as deciduous trees/creepers, adjustable awnings etc, to protect these windows from heat gain.
East	Minimise windows where possible, provide deep overhangs, external blinds or pergolas.
West	Eliminate windows where possible. Provide the ability for complete shading with deep pergolas and/or other external shading options.
South	Minimise large windows and provide some weather protection, while allowing for ventilation and air flow during summer.

(Source: DCCEE, 2010)

Window and door systems are available in a variety of material combinations. Glass panes are available in single, double or triple layers, with multiple pane systems being more efficient than single glazing. In general, double glazing is beneficial for all orientations and also enhances noise reduction and security measures.

Window frames are commonly made of aluminium, wood or PVC. Wood and PVC frames offer better resistance to heat transfer than metal frames which have high heat conductance resulting in greater heat loss and gain.

Metal frames can be designed with a thermal break (gap) to decrease the level of heat transfer and improve efficiency. Timber frames have lower embodied energy and superior resistance to heat transfer compared to standard aluminium frames, however they require greater effort to maintain.

Glazing combinations are measured with a U-value. The U-value is the ability of a material to conduct heat. Table 2 displays examples of the U-value for a range of window materials and systems.

The lower the U-value the greater the resistance to heat transfer and the higher the material's insulating ability.

Table 2: Examples of window systems and the associated total heat transfer.

Window Frame Material	U Value of Glazing Systems (W/m²/˚C)		
	Single Glazing	Double Glazing	Double Glazing & Low-e Coating
PVC/timber	4.5	3.0	2.4
Aluminium - with a thermal break	4.6	3.1	2.5
Aluminium	5.5	4.0	3.3

(Source: SV, 2009)

Combinations for window systems should be carefully considered before purchase. The Windows Energy Rating Scheme (WERS) rates a window's energy performance out of 5 stars. Purchase windows with a high star rating for improved efficiency and comfort levels.

Quality glazing (glass treatments such as solar films, magnetic acrylic panels or configurations such as double-glazing), combined with shading and internal window coverings add value to a property and make a home more comfortable to live in.

Windows are often the weakest link in a dwelling when it comes to winter heat loss and require additional protection. To reduce heat loss in winter it is necessary to trap a layer of still air next to the window itself. As shown in Table 3, a combination of double glazing, heavy drapes and pelmets can form an effective treatment for improving winter window performance.

Table 3: The effects of window treatments on winter heat loss

Percentage of WINTER HEAT LOSS for window treatments	
Unprotected single glazing	100%
Vertical or venetian blinds	100%
Unlined drapes or Holland blinds, no pelmets	92%
Heavy, lined drapes, no pelmets	87%
Unlined drapes or Holland blinds with pelmets	79%
Double glazing*	67%
Heavy, lined drapes with pelmets	63%
Double glazing with low-E coating*	57%
Double glazing, heavy drapes and pelmets*	46%

** Some double glazing window systems may perform substantially better than this.*
(Source: Sustainable energy info fact sheet, Window Protection.)

Unprotected glass windows can significantly contribute to summer heat gain. Restricting the penetration of hot summer sun is critical to keeping your home cooler. External shading, such as vegetation, louvres, eaves and external blinds offer superior protection from summer heat gain compared to internal window coverings. In addition, options like correctly designed eaves that restrict sun penetration are one of the least expensive long term shading tools to reduce heat gain over summer.

Table 4 provides examples of the amount of heat gain that can occur with various types of window protection.

Table 4: Comparison of heat gain in summer through different window treatments

Percentage of SUMMER HEAT GAIN for window treatments and protection	
Unshaded single glazing	100%
Double glazing	90%
Vertical blinds/ open weave drapes	76%
Internal venetian blinds*	55-85%
Internal drapes or Holland blinds	55-65%
Tinted glass#	40-65%
Solar control or reflective films#	20-65%
Trees full shade	20-60%
1 metre eaves over north wall	30%
Roller shutters	30%
External awning	25-30%
2 metre pergola over north wall with deciduous plants or shade cloth	20%
Outside metal blind or miniature louvres parallel and close to the window	15-20%

** Effectiveness is reduced as colour darkens*
 # Solar films, tinted glass and reflective glass have varying effectiveness. They all significantly reduce levels of light all year round
(Source: Sustainable Energy of Victoria, Sustainable energy info fact sheet, Window Protection)

Thermal Mass

Thermal mass is the ability of a material to absorb and re-release heat energy. Adding thermal mass inside a well-insulated building envelope helps smooth out the effects of fluctuating temperatures. When correctly applied, high thermal mass materials can be used to store daytime heat which is later discharged over night when needed.

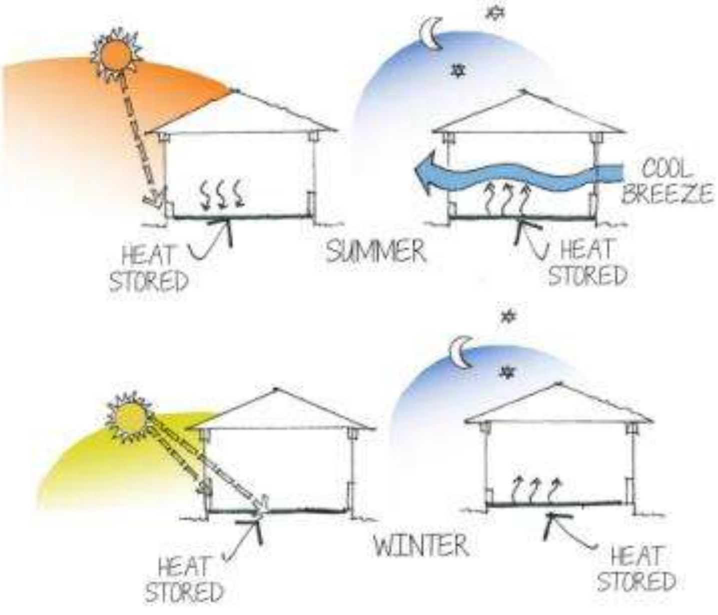


Figure 4: Seasonal use of thermal mass. The higher position of the summer sun and the use of eaves restrict heat penetration. In winter, the lower path of the sun across the sky allows for solar penetration and promotes heat storage in the high thermal mass flooring, which is later released over night. (Source: DCCEE, 2010)

In winter, thermal mass stores heat from direct sunlight or radiant heat sources, this heat is released back into the house at night when the temperature drops. During summer, thermal mass surfaces should be protected from direct sunlight by shading and window coverings. Cooling night breezes can be used to draw out and remove any stored heat from the building (see Figure 4). Generally, thermal mass is located in north-facing living areas with good solar penetration, access to cross-ventilation and exposure to any additional heating or cooling sources.

The location of thermal mass within the building will have an enormous impact on heating and cooling performance. Using concrete or tiles as flooring is a common and economical location for thermal mass within the home. Additional thermal mass can be added by constructing dense material walls of brick, stone or poured earth (refer to Figures 5-7). Seek good advice when employing thermal mass to ensure appropriate use.



Figures 5-7. Thermal mass used within homes. Left to right. Internal poured earth wall, polished concrete floor, concrete brick walls.

Insulation and Draught Proofing

A well insulated home offers a barrier to the transfer of heat in and out of the building. It is also one of the most important energy efficient actions you can undertake when building. Insulation offers a number of benefits including:

- improved comfort levels
- reduced heating and cooling costs
- discouraging condensation build up
- improved sound proofing

Building insulation comes in many forms. The main products are bulk and reflective, or a composite of the two. An R-value is assigned to the insulation product and provides a measure of the resistance to heat flow. Use the highest R-value insulation material available to you.

The higher the R-value the better the thermal performance and the greater the resistance to heat transfer.

Figure 8: Floor insulation can minimise heat transfer through wooden floor boards.

You can save up to 45% on heating and cooling energy with ceiling and roof insulation, up to 20% with wall insulation, and an additional 5% with appropriate floor insulation (see Figure 8). Thermal mass is not a substitute for insulation. Common building materials such as brick, timber and tiles have little inherent insulation value and hence still require additional measures. Installing insulation is relatively inexpensive for the benefit it provides and is more easily accomplished during initial construction.

Choosing dark coloured materials for the roof of your home should be avoided. Using a dark colour may heat the roof space considerably during summer, which adds to the heat load on your home. This impacts comfort and increases the need for additional cooling. Solar paints can offer insulation through a heat reflective coating on the roof. Light coloured solar paints offer the best performance reflecting up to 80% of solar radiation.

In addition to insulation, prevent draughts and "weatherseal" your home to prevent unwanted heat loss or gain.

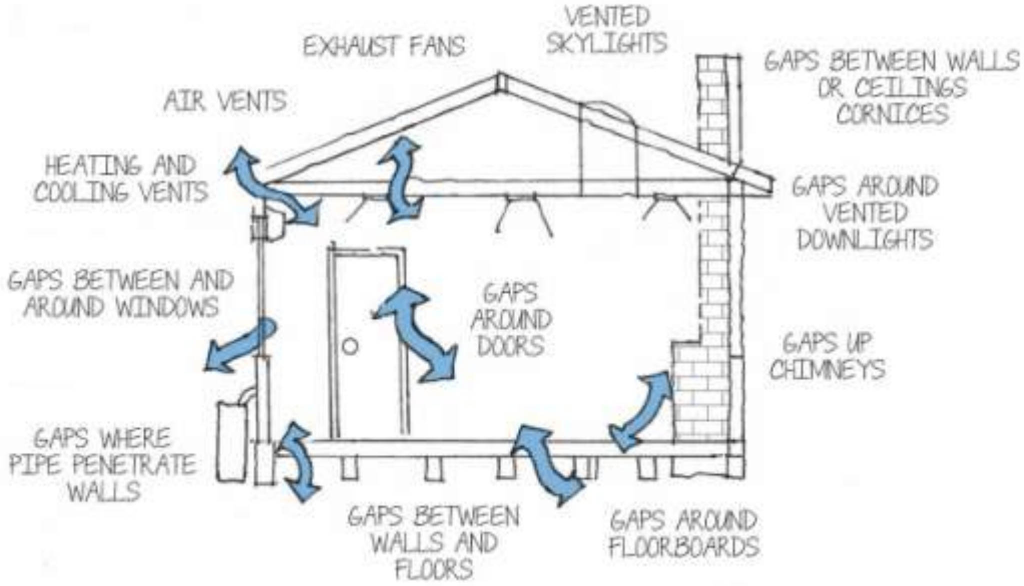


Figure 9: Typical sources of air leakage (Source: DCCEE, 2010)

Air leakages can account for 15-25% of winter heat loss in buildings. As shown in Figure 9, typical areas for leakages are air vents, open fireplaces, doors, windows, floor-boards and gaps where pipes, appliances or lights penetrate the roof and walls. Identify and seal air escaping through gaps and cracks in the building to strengthen insulation measures.

Material Selection and Trade Offs

All materials have an economic, environmental and social cost associated with them. Often the impact of a particular material or construction system is not apparent to the consumer, as these costs occur during harvesting or manufacture. Owners will be faced with a number of complex decisions and need to consider many factors that at times may conflict.

Material characteristics that will need to be considered include:

- cost and skill availability to work the material
- source of the material
- environmental and health impacts of using the material
- thermal and insulation performance of the material
- maintenance, durability and life cycle of the material
- adaptability of a product
- embodied energy of material (commercial energy used to produce a product, bring it to market and dispose of it)
- climate and design intention versus material suitability.

When selecting building materials, aim to reduce and reuse where possible and avoid hazardous materials. Avoid old growth timbers, toxic substances and high VOC (Volatile Organic Compounds) products. VOCs are potentially harmful chemical compounds that may be found in a number of building materials including paints, vanishes, finishes, adhesives, particle boards and carpets. Source low VOC or zero VOC alternatives to reduce potentially harmful off gassing. If considering a high embodied energy product plan for use with energy efficient design and seek low maintenance highly durable options.

In addition, source products that have a high recycled component (see Figure 10). Using recovered materials and buying local materials can save on cost and reduce the embodied energy of a product.

Figures 10: A wood composite product was selected to use in the building of a new deck. The timber look-a-like product is made from recycled timber and plastic and has the look and feel of timber but without the traditional maintenance requirements.

Waste - Reduce, Reuse and Recycle

Building waste such as bricks, concrete, wood and insulation comprises up to 40% of all waste generated in Australia. Furthermore, construction materials use mostly finite resources. Excess construction waste is economically ineffective, wastes valuable materials, uses up energy for production and transportation, and potentially consumes limited landfill space.

The primary aim of waste reduction is to reduce, reuse and recycle.

Reduce waste by:

- designing to common lengths of materials in order to reduce off cuts
- reusing existing materials to reduce demand on resources
- recycling materials that can be adapted for another purpose
- recycling off cuts or excess materials

Small and Smart

An overwhelming trend in modern house design is for larger homes with smaller gardens and outdoor areas. While there are many attractions to owning a larger home they generally come with significant environmental and financial costs. A larger home requires a greater volume of raw materials to construct, greater effort to clean and maintain and presents a bigger area to heat and cool. A smaller, well designed, quality home may adequately meet the needs of the occupants while offering improved efficiency and fewer environmental impacts.

In addition, each home-owner will have different needs for their home and this will change over time. When planning a design consider carefully how the house can flex and evolve to meet immediate and future needs - good design is always better than bigger design.

Planning for the Future

In building your new home you will need to balance available funds with your ambitions. If the current budget presents a barrier to sustainable design consider whether there are efficiency features that can be prepared for during the building phase. A smaller outlay and preparation may allow for a less expensive retrofit at a later date.

Typical options may include:

- wiring to allow later installation of solar photovoltaics for electricity generation
- allowing space for a large water tank and connecting wiring and plumbing to service household amenities such as the laundry and toilets, as well as watering the garden
- installing hydronic-heating pipes for later connection to an appropriate heat source.

Energy

Minimise the use of energy and non-renewable resources.

Top Tips

1. Install an advanced or solar hot water system suitable for your local climate.
2. Use zoning to reduce the area to be targeted when heating or cooling.
3. For additional heating investigate appliances that use renewable energy or have high efficiency.
4. For additional cooling use ceiling or portable fans.
5. To further reduce heating and cooling needs install quality insulation, reduce draughts and use window protection, furnishing and glazing solutions.
6. Install renewable energy technology.
7. Purchase green power if additional energy is required to encourage the renewable energy market.
8. Maximise the use of natural lighting.
9. Purchase energy efficient artificial lighting.
10. Use zone or task lighting.
11. Purchase correctly sized and energy efficient appliances.

Hot Water

Hot water is typically a large component of household energy use. Advanced solar thermal hot water systems with either an electric or gas booster attached, have lower yearly operating costs than conventional systems. There are a number of technologies available with some more suitable than others depending on local climate, booster energy options and the hot water supply needs of the end user.

Heat pumps are very efficient electric systems that don't use sunshine directly, but rather use the heat energy present in the outside atmosphere to produce hot water via a heat exchange system. In basic terms, the heat pump draws air into the unit, where a refrigerant extracts the heat energy from the air which is then used to heat the water in the storage tanks. Heat pumps may be a good option in areas without mains gas supply.

Solar hot water systems such as evacuated tube or flat panel systems have roof-mounted solar collectors that capture the sun's radiant energy. The energy is used to heat the water in the collectors before the water is transferred to a storage tank. An electric or gas booster is used when weather conditions are unfavourable and the required hot water supply cannot be maintained using solar energy alone.

Evacuated tube systems are widely considered to make more efficient use of the sun's energy when compared to flat panel options. They also perform better over the cooler months or cloudy periods and withstand lower temperatures without the need for anti-freeze fluids and frost prevention measures.

Questions to consider when selecting advanced hot water options include:

- Do I need frost protection?
- What size system do I need for my home/family?
- What type of booster can I fit to the system?
- Is the location of the system appropriate?
- Is any noise generated by the system going to be a problem?
- What rebates are available to help reduce the cost of my system?

For hot water systems in Indigo Shire consider using:

- a heat pump connected to a timer to target operation during the day when heating ability is greatest, and restrict booster operation overnight when hot water demand is less (unless specifically required)
- an advanced evacuated tube solar system boosted by natural gas (Rutherglen/Chiltern areas) or electricity (Beechworth/Yackandandah areas)

Figure 11: Slow combustion wood heater installed to act as a heat source and wet back boiler.

If possible, hot water systems should be located close to the intended area of use and pipes should be insulated to reduce heat loss. A timer or manual boost switch can be fitted to an electric boost solar hot water system to avoid heating the water when hot water is not required.

Also worth consideration is integrated hot water and heating systems. Most hydronic systems can supply economical and highly effective heating with the option of providing hot water. Water is heated in a boiler and then pumped through the home via coils or panel radiators to provide heating. Boilers are commonly fuelled by gas or wood although “combination” hydronic systems that use a solar system to supply hot water are also available.

In Figure 11, a slow combustion wood heater is being installed to act as a heat source and wet back boiler. The set up will supply household heating and hot water over the winter months. During installation provisions were also made to allow connection to solar hot water to meet needs during warmer months.

Heating & Cooling

Mechanical heating and cooling account for a large component of the typical household energy budget. Reduce your heating and cooling requirements through good design and by zoning (closing off) main living areas to minimise the area being targeted. In addition, install quality insulation throughout the home (roof, wall, floor) and draught proof where necessary.

If additional heating is required during extreme conditions, consider:

- ✓ hydronic or geothermal heating, high efficiency gas, efficient electric heat pump split systems or wood heaters fuelled from renewable sources rather than energy intensive electric radiant heaters
- ✓ gas heaters and efficient reverse-cycle split systems produce only one third the amount of greenhouse gas emissions of standard electric heaters
- ✓ slow combustion high efficiency wood fires are substantially more efficient then open fire places
- ✓ maximising internal exposure of the flue to utilise radiant heat
- × electric in-slab heating generally has the highest greenhouse gas emissions of any heating system as well as typically being expensive to run - hydronic floor heating can be a more efficient floor heating option

Mechanical cooling options usually focus on evaporative cooling or refrigerated air-conditioning units. High efficiency inverter air conditioning units can supplement both heating and cooling needs. Evaporative coolers use less energy than refrigerated air conditioners yet water consumption can be considerable and their performance is adversely affected during periods of high humidity. Ceiling fans (as pictured) or portable fans provide both cooling and air movement and offer a cost effective alternative. Many ceiling fans have a summer/winter switch to reverse blade movement and assist heat distribution during winter.

Figure 12: High level ceiling fan

Lighting, Appliances & Products

Efficient lighting within a house takes advantage of both well planned natural lighting and the use of energy-efficient globes and dimmer switches. Energy efficient technologies such as compact fluorescent (CFL) and LED light globes have improved in quality over the years and are now readily available. These should be fitted to meet a home's artificial lighting requirements

A common household design trend is the excessive use of down lights to illuminate entire rooms. Standard halogen down lights are very inefficient. The average 12v 50w halogen down light coverts 90% of the energy used to heat and only 10% into light. In contrast, currently available LED down lights use around 10% of the energy of standard halogen globe, yet provide up to 85% of the light output and last 20-50 times longer than their halogen equivalents. Minimise the use of halogen down lights and install energy effective alternatives such as LED down lights, compact fluorescent down lights, or improved energy efficient halogen options.

If fitting down lights for the purpose of task lighting such as reading, ensure they are installed correctly with respect to insulation. The use of zone or task lighting allows for lower energy consumption to satisfy targeted activities.

Smart appliance selection can also help reduce energy consumption. Consider energy rating labels and size suitability when selecting goods such as refrigerators, dishwashers, washing and drying machines, heating and cooling appliances. You may also need to consider water consumption with many appliance decisions.

Look for appliances with 4 stars or greater.

The label (see Figure 13) has two main features:

1. A star rating out of 6 that compares like sized appliances. Aim for four or more stars.
2. A yearly consumption figure that estimates typical energy use in a home.

Balance the lowest possible energy consumption with appliance features, appropriate sizing for purpose and capital costs.

Figure 13: Appliance energy rating label.

Electricity Generation

Energy can be produced through renewable, naturally replenishing sources such as the sun, wind, wave, hydro, geothermal and organic matter (biomass). Of these options solar photovoltaic (PV) and wind turbines are the most common on-site renewable technologies used across residential Australia.

Figure 14: A roof mounted solar PV array that produces half of this homes annual electricity requirements.

Solar photovoltaic panels generate electricity that can supply part or all of your household energy needs. Solar panels work best when they are installed on a north-facing roof and correctly angled to the sun while avoiding any angled shading (see Figure 14). Once installed, they require little maintenance and can be expected to last 20 years or more. Photovoltaic panels are becoming a more attractive energy solution as electricity prices rise. Incentive schemes and feed-in tariffs can also help reduce the initial cost of PV installations and reduce payback periods.

Domestic wind turbines are standalone power systems that convert wind energy into electricity. Vertical and horizontal axis technologies are available for household applications. Turbines are usually intended to charge a battery pack. Criteria such as land and wind availability should be explored to determine the feasibility of the system for your particular location.

In addition to home electricity generation, additional energy needs can be sourced through accredited Green Power energy providers. This is usually available on request and come with a premium charge.

Renewable electricity is a dynamic field that is constantly evolving. Review new technologies and explore rebates or initiatives available through local, state or federal programs as these can change from time to time.

Water Management

Conserve water and reduce your reliance on mains or potable water supply.

Top Tips

1. Integrate a large rainwater tank for garden watering, toilet flushing and laundry. Choose the largest rainwater tank you can afford for your budget and space.
2. Consider installing additional and oversized downpipes to help manage deluges associated with storm events and heavy rainfall.
3. Buy water-efficient appliances and devices, e.g. low flow shower heads, tap aerators, dual flush toilets and front loading washing machines.
4. Create a water smart garden.

Australia is the driest inhabited continent on Earth, but Australians are one of the highest per capita users of water in the world. In order to reduce consumption water efficiency should be incorporated into the design of dwellings, gardens, and when selecting appliances and plumbing fixtures. A large amount of embodied energy is contained in the delivery of treated "potable" drinking water. In addition, a large amount of high quality "potable" water is used on our gardens when other options may be available. Rainwater is a natural and free supply of water. Installation of a large rainwater tank can offer a valuable alternative to mains water for garden irrigation and select household activities such as flushing your toilet or washing laundry.

Grey water is wastewater derived from specific domestic activities such as bathing, laundry and dishwashing. It may be recycled onsite and used for some house and garden activities. Design plumbing to integrate rainwater supply and reuse grey water, if possible, to reduce consumption of mains water.

It is projected that greater frequency and intensity of storm events will occur in the future. Increasing the sizing of guttering and downpipes may help manage heavy rainfall and support additional rain water capture.

Select water efficient appliances and devices when fitting out a new home. Products that use water will be rated using the WELS rating scheme. This national water rating tool allows buyers to compare water consumption or flow figures of products. In addition each product is given a star rating. The greater the number of stars the better the water efficiency of the product.

Rebates for water-efficient products may also be available. Check with your water providers or relevant government agencies for more information.

Traditionally household wastewater is managed either by connecting to the municipal sewerage system, or installing a septic system. Alternative treatment methods including; aerated waste water treatment plants, worm farms, composting toilets, and reed beds, may be considered. Each of these has varying chemical, energy and water needs. Before proceeding with a particular system, a number of criteria may need to be considered such as the land capability in terms of soil condition and land contours, as well as any property planning provisions.

Figures 15-18: Ways to cut down on household potable water use. Left-right: Rainwater tank to supply garden and some household activities, composting toilets, and low flow shower heads.

Landscaping

Landscape to support passive design and add beauty and amenity, while conserving water

Top Tips

1. Plant for passive design and shading.
2. Plant local native, drought tolerant species.
3. Plan for the installation of vegetable gardens, compost plots, rain water tanks and a clothes line.
4. Reduce the extent of lawned area or areas dependant on watering. Consider planting native grasses, ground covers or including gravelled areas as an alternative.

Landscaping can add appeal to your property while enhancing outdoor living areas and providing habitat for local fauna. Garden design and the selection of trees and shrubs should complement solar passive design while planning for periods of drought and bushfire protection.

Use deciduous plants, such as trees or vines on the northern aspects to allow for summer shade, while permitting sun to penetrate in winter for passive solar heating (as shown in Figure 20). Evergreen plants can be used to shade the east and west faces of the house. Screening plants may also be used to provide wind breaks or channel breezes towards your home to assist with cross ventilation and cooling. Always consider drought-hardy plants and turf that have minimal water requirements once established, while being wary of weed species.

Some areas in Indigo Shire are affected by a Wildfire Management Overlay and may be subject to vegetation management requirements that affect planting around a building used for accommodation. Refer to the Country Fire Authority (CFA) and/or Building Commission for further information.

Additional design considerations include placement of proposed vegetable gardens (see Figure 19), composting plots, water tanks and an outdoor clothes drying area. Install drip irrigation and top dress garden beds with mulch to reduce moisture loss. Use natural fertilisers and herbicides for plant maintenance.

Principles of waterwise gardening:

- Improve the soil.
- Grow the right plants - plant low water, drought tolerant plants and local native species (see Figure 21). Check the flammability of these species.
- Mulch garden beds and pots to reduce evaporation and run off.
- Remove weeds that compete for water and nutrients.
- Reduce lawn - use drought tolerant turf or native grasses and ground covers.

Resource material on the selection of indigenous plants for your area can be obtained from Indigo Shire, Landcare and the Department of Sustainability and Environment (DSE).



Figures 19-21: Left-right. Vegetable patches can supply food, pergolas can enhance passive design – shade in summer and allow sunlight in winter, and select native plants for landscaping to reduce watering requirements.

PART B – Build Styles

“more than just bricks and mortar”

Build Styles

Building styles vary according to personal taste, locations, climate, technology and finances. Depending on the suitability of a particular build style to the local conditions, additional design elements may have to be incorporated to ensure greater comfort and a more cost effective operation. By understanding the strengths and weakness of a particular build style, options can be considered early to deliver a comfortable and affordable home.

Build styles presented in this section include:

- clay brick – typical brink veneer, double brick and reverse brick
- timber
- Autoclaved Aerated Concrete (AAC)
- straw bale
- mud brick
- rammed earth (pisé).

Clay Brick

Conventional bricks are made from clay material that is cut to shape and then oven fired. They are mass produced across Australia and present a number of attractive building properties such as high durability and compressive strength along with high thermal mass and excellent fire resistance and sound proofing.

Typical Built Brick Veneer

Brick veneer is the most common build method used in Australia. Buildings usually have a timber or steel frame with an external wall of clay bricks (see Figure 22). This method is popular because it is generally inexpensive (although costs are similar to reverse brick), with quick construction and low maintenance requirements. The thermal mass of the bricks may not be used to greatest advantage as the bricks are located on the outer wall and exposed to the external weather conditions. For this reason, this style does a similar job to any other form of cladding except with the capacity for long life and low maintenance requirements. Brick veneer buildings should be well insulated to protect from the outside conditions. The application of passive design elements will help improve performance outcomes.

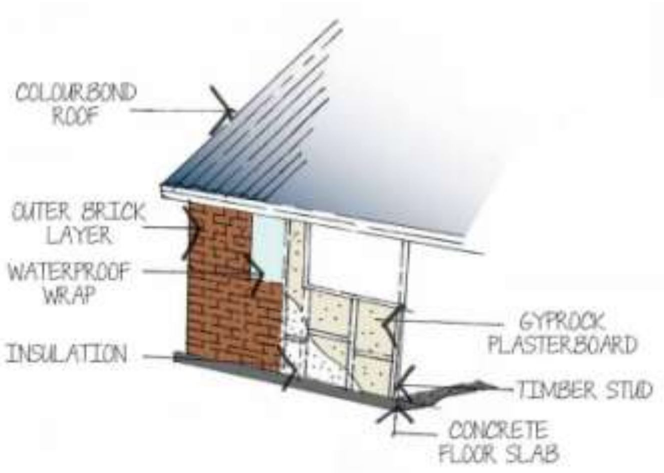


Figure 22: An example of a typical brick veneer construction. This illustration displays an outer brick shell and internal plasterboard lining.

Reverse Brick Veneer (RBV) – bricks on the inside rather than the outside

This style of build has a thermally dynamic frame with cladding of the outer wall and the bricks used to construct the inner shell (see Figure 23). This approach may be better suited to the majority of Australian locations compared to the more common standard brick veneer construction. The thermal mass of internal brickwork can be used to moderate the internal temperature while the external cladding offers weatherproofing to the structure.

Cladding usually takes the form of timber weatherboards, metal or fibre cement sheeting. The internal and external linings should be separated by quality insulation to restrict the inner brickwork from being exposed to external weather variations. When used in conjunction with solar passive design the thermal mass of the internal brickwork acts to more effectively even out interior temperatures and lowers the demand on both heating and cooling.

If considering a brick build, reverse brick veneer may be thermally preferable when compared to standard brick veneer for locations across Indigo Shire. However, the durability and maintenance requirements of the external cladding should be thoroughly considered.

The concept of a reverse veneer construction can apply to almost any high thermal mass material. Alternative building materials such as other masonry products, mud-brick, concrete bricks, stone, rammed or poured earth may be used to construct the internal shell.

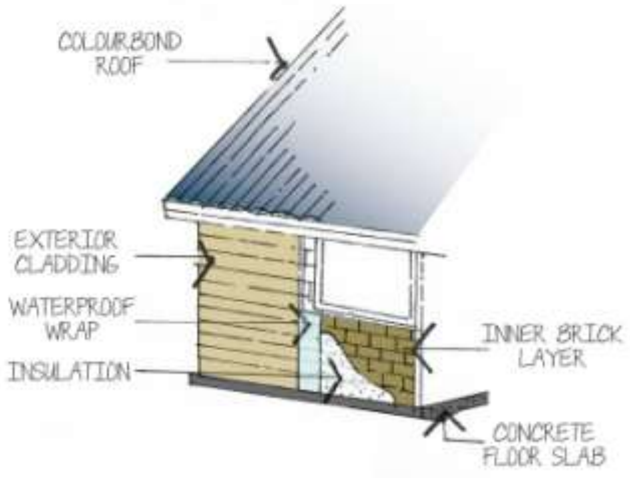


Figure 23: An example of a common construction method for reverse brick veneer homes.

Double Brick (also known as full brick, solid brick or cavity brick)

Double brick homes have both an inner and outer wall of bricks separated by a cavity to prevent moisture from penetrating into the home (see Figure 24). The internal brick wall is either left raw, rendered, or covered with a plaster board lining. It is extremely durable and requires little maintenance while providing considerable thermal mass.

Using passive design, this style can provide natural levels of climate comfort without having to constantly resort to artificial heating and cooling. The double shell and high thermal mass has the ability to shelter occupants from extremes in temperature. The internal brick work is capable of storing and slowly releasing heat to provide this smoothing effect.

This type of dwelling has very good sound proofing and termite resistance. The quantity of materials required may make projects more expensive and labour intensive with high associated embodied energy. In addition, the heavier construction usually requires more substantial and expensive footings and floor slab. As walls can be difficult to access after completion it is best to consider plumbing and electrical design early to minimise changing of services during construction.

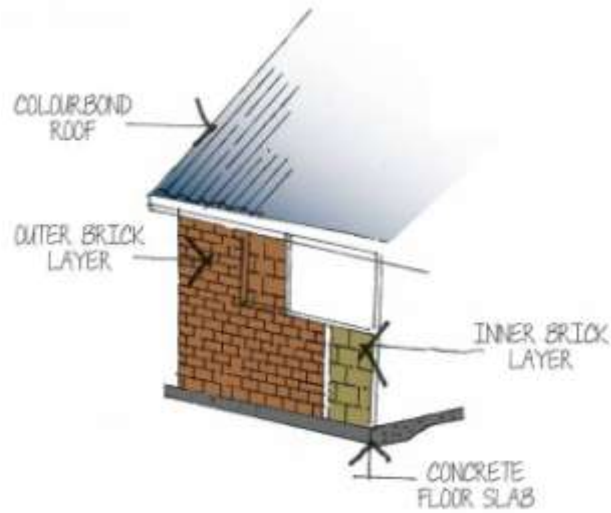


Figure 24: An example of a common construction method for double brick homes

Clay Brick Performance Summary

Appearance/Finish	Variety of colours and textures. Most commonly used uncoated but can be rendered.
Structural Capability	Fired clay bricks have high compressive strength.
Thermal Mass	High thermal mass. Internal brick walls can offer effective thermal performance if correctly applied to passive design.
Insulation	The thermal resistance of clay bricks builds can be greatly improved by installing foil and/or bulk insulation. Bricks have excellent sound insulation/proofing qualities.
Fire and Vermin Resistance	Excellent fire resistance and do not harbour vermin.

Durability and Moisture Resistance	Excellent weathering resistance and durability, little to no maintenance. Moisture will eventually soak through the mortar joints. Construction methods will usually be incorporated to manage any moisture that may enter the cavity.
Toxicity and Breathability	In general bricks are inert and not prone to off gassing of VOCs (Volatile Organic Compounds).
Environmental Impact	Commonly clay bricks have very high embodied energy due to manufacture. However, they have excellent durability and can be reused, or crushed and used for other purposes such as road and path construction.
Buildability	Widely used in Australia, expertise in working with bricks is extensive. Costs are competitive due to their demand.

Timber

Timber is a commonly used building material. It is strong, flexible and easy to work with, and widely used as the main building material and cladding in tropical areas or places with low diurnal or "daily" temperature variations. In such areas, light weight constructions can respond quickly to cooling breezes. The flexible nature of timber houses can make them appealing in areas where clay soils can cause foundations to move. The following summary focuses on timber clad housing.

Timber Performance Summary

Appearance/Finish	A variety of techniques are used to protect and finish most timbers such as paints, vanishes and natural oils.
Structural Capability	Timber has high strength for its weight. When correctly engineered it can support high loads such as roof trusses and framing as well as cladding. It can be used on a variety of foundations.
Thermal Mass	Softer, lighter timbers have little to no thermal mass. Higher density timber offers moderate thermal mass but have short thermal lag times (store and release heat quickly).
Insulation	Timber clad homes should be well insulated to control temperature fluctuations. Additional thermal mass may be advisable if artificial heating is required. Timber floors may need to be insulated and the perimeter enclosed to achieve suitable thermal performance.
Fire and Vermin Resistance	Some woods are more susceptible than others to insect attack and in general timber is highly combustible. Timber may not be desirable in either areas of strong white ant activity or high fire risk areas. Careful selection of timber species can reduce risk of white ant and fire vulnerability.
Durability and Moisture Resistance	All timbers will eventually rot and should be protected from the environment. Regular maintenance will be required to safe guard against deterioration. Some woods are better suited for outdoor use then others.
Toxicity and Breathability	Timber is generally non toxic and breathable although finishes may alter this. Lower VOC finishes are generally water based rather than solvent based.
Environmental Impact	Timber is a renewable building resource. It can be sourced through sustainably certified suppliers where timber is grown and managed responsibly. Timber can also be reclaimed and recycled. It has low embodied energy especially if sourced locally, although manufacturing adds to impacts. Timber is biodegradable. The high maintenance requirement to protect exposed timber with the application of paints and finishes may increase impacts.
Buildability	Easy, versatile material to work with and alter at a later date. Allows for easy connection of services. Expertise in working with timber is extensive.

Autoclaved Aerated Concrete (AAC)

Autoclaved Aerated Concrete (AAC) has been used as a building material in Europe for over 60 years, and more recently in Australia over the last 20 years. The lightweight blocks (or panels as used in Figure 25) come in a range of sizes and thicknesses and are comprised of concrete that has numerous closed air pockets (voids) throughout the material. The concrete is manufactured from sand, cement, recycled material, lime, gypsum, aluminium paste and an aerating agent which causes the concrete to foam. The product is then cut and cured by steaming (autoclaving). Blocks can be applied to builds in a similar manner to traditional masonry bricks and be used as a single or double skin and veneer to a timber or steel frame.

Figure 25: An AAC panel home. The panels have been finished with a render to seal the material.

AAC Performance Summary

Appearance/Finish	Light coloured with voids throughout the fabric of the material. An additional coating or render may be applied to restrict water penetration. Due to its softness AAC can be sculpted with wood working tools.
Structural Capability	Very good compressive strength. Can be used for a wide range of load bearing and non-load bearing construction applications.
Thermal Mass	Moderate overall thermal mass performance. Most useful in climates with high cooling needs.
Insulation	Very good insulation qualities. Additional insulation may be required to meet some Building Code of Australia (BCA) requirements but the combination of moderate thermal mass and thermal insulation properties translates into good thermal efficiency helping to reduce heating and cooling costs. Can also provide very good sound proofing.
Fire and Vermin Resistance	The inorganic blocks offer excellent fire resistance and do not encourage vermin or termites.
Durability and Moisture Resistance	The lightweight nature of AAC can make them susceptible to impact damage yet the constructed building offers significant longevity. The porous nature of the material allows some moisture penetration that may affect thermal performance. A variety of finishes may be applied to protect surfaces and restrict moisture infiltration.
Toxicity and Breathability	The porous nature of the product assists breathability. It is also non-toxic and does not emit gases or odours. Applying finishes may alter this. Low toxic surface coatings can be selected to finish product. As with any concrete type product, care should still be taken when handling and cutting the material.
Environmental Impact	Moderate embodied energy. Being porous with low bulk density AAC requires less raw material than standard concrete to manufacture the same sized blocks. This represents lower embodied energy compared to concrete or brick veneer alternatives. Off cuts can be recycled, reused for aggregate or reused elsewhere on the build.
Buildability	The material is relatively quick and simple to work with and can be easily cut, carved and sculpted with standard power tools. Care should be taken by skilled workers when placing blocks and constructing walls.

Straw Bale Construction

Straw bale buildings have thick straw walls covered in a render to seal and protect the straw bales. They first appeared as a construction method over 100 years ago when baling machines were invented. Straw bales are commonly referred to as a renewable building material as the product is grown using energy from the sun and then harvested. Different to "hay", which is a feedstock, straw is derived from crops such as wheat, rice, rye and oats. Typically straw bale buildings consist of rows of bales on a raised footing or foundation with a render applied inside and out to seal the walls.

Figure 26: The thick straw bale walls of this home have been covered with an earthen render to seal and protect the building material.

Straw Bale Performance Summary

Appearance/Finish	Usually rendered with earth, lime or cement. Walls can also be clad although this is not as common.
Structural Capability	Good structural capacity. Can be load bearing or non-load bearing using a frame although most will require a frame to comply with building standards.
Thermal Mass	Low thermal mass as bales are composed mostly of air. The applied render may provide considerable thermal mass depending on the thickness and type. Often high thermal mass floor systems are used to enhance a buildings thermal mass.
Insulation	Excellent and very cost effective insulation. Straw bales provide low cost and very effective sound proofing.
Fire Resistance and Vermin Resistance	Very good to excellent fire resistance, due to tight bale packing and application of external render. A completed wall has an excellent resistance to vermin but it is important to prevent infestations during construction and vermin-proof the building as a whole.
Durability and Moisture Resistance	Repeated exposure to moisture is detrimental to the durability of the structure and bales should be well protected during construction to prevent rot. Once suitably sealed, walls offer good moisture resistance.
Toxicity and Breathability	Being a natural material, straw bales are safe and biodegradable and have good breathability especially with earthen renders.
Environmental Impact	Straw is an agricultural waste product that is usually burnt. As such, building with straw bales allows for carbon storage and reduces air pollution. The bales themselves have low embodied energy. Locally sourced bales help reduce transportation impacts. Chemicals used during the farming process, twine, and energy used to bind the bales will increase the environmental impact. Straw is also biodegradable.
Buildability	Simple straightforward construction lends itself well to home builders and workshop programs. Generally materials have low cost and are seasonally available by arrangement (as straw bales for building would normally be pressed to a greater density). Due to the thickness of the walls significant building area is taken up with wall construction.

Mud Brick (Adobe)

Mud bricks are one of the earliest known building materials. The bricks take advantage of a readily available natural resource being made by placing suitable soil material and water into moulds to dry. The characteristics of the brick material may be varied by mixing different soils, adding straw for reinforcement, adding stabilising materials, admixture or the like. They are cheap and require little or no processing with virtually all the energy required to make the brick coming from the sun or in the form of human labour.

Mud Brick Performance Summary

Appearance/Finish	Appearance and colour can vary depending on the clay and sand composition. Texture and surface finishes can be applied to the brick work. For example bagging, earthen render, linseed oil.
Structural Capability	If the walls are thick enough the structure may be capable of considerable load bearing capacity. Alternatively mud brick can be used as an infill for a building frame. Builds can be multiple-storey and engineered into domes and vaulted ceilings.
Thermal Mass	If sufficiently thick (generally a minimum of 300mm for Australian conditions) mud brick walls provide moderate to high thermal mass.
Insulation	Mud bricks have low R values and are not good insulators. Good passive design should be incorporated to take advantage of their thermal mass. It may be advisable to install additional insulation in some climates to reduce heat loss in winter or alternatively consider double skinned constructions. It does however have very good sound proofing.
Fire and Vermin Resistance	Being a natural “dirt” product mud brick does not readily burn and hence provides excellent fire and also good vermin resistance.
Durability and Moisture Resistance	Structures several centuries old are still in service. Mud brick homes should be protected from extreme weather and have adequate eaves protection to reduce exposure to moisture.
Toxicity and Breathability	Claimed to have the ability to “breath”. Additional strengthening agents, such as bitumen or cement, may alter the health of the end structure.
Environmental Impact	Mud bricks have low embodied energy due to their simple and usually local manufacture. Water consumption may be considerable during brick manufacture.
Buildability	Although generally labour intensive, mud bricks are easy to manufacture and work with, proving an attractive option to owner builders. Mud brick production is suited to a wide range of soils. Testing of mud bricks may be required if bricks are to be load bearing.

Rammed Earth – (Pisė)

Rammed earth is an ancient construction method that places damp or moist raw earth and selected aggregates including gravel, sand, silt and small amounts of clay between flat panels called formwork. The mix is then compacted by ramming to a suitable density. Modern methods use a mechanical ram to compress the mix. Houses are created in place with solid masonry walls and no cavities.

Walls are best constructed in warm weather where they can dry and harden. The wall curing process may take up to two years to be complete.

Small amounts of cement and other admixtures can be added to stabilise soil material thus adding strength and durability to the traditional approach. Unstabilised rammed earth should be protected by eaves, overhangs or render to minimise erosion.

Figure 27: Rammed earth wall

Rammed Earth Performance Summary

Appearance/Finish	Earthen appearance. Colour can vary depending on the material composition used to create the walls. Walls can also be textured (using a wire brush) or oxides added for colour. Surfaces are often coated with a permeable sealer to increase the durability of the material. In addition, the ramming process often produces horizontal stratification layers through walls (see Figure 27). Interior walls may need to be coated with a suitable material to limit dust.
Structural Capability	Very strong compressive strength and can be used for multi-storey buildings.
Thermal Mass	High thermal mass. Internal walls provide considerable thermal mass for passive heating and cooling.
Insulation	Moderate insulation as it is generally used in single skin constructions. Wall thickness may be increased to improve performance. Alternately, additional insulation measures may be required. Excellent sound proofing.
Fire and Vermin Resistance	Very high fire resistance due to a lack of flammable ingredients in wall construction. With no cavities to harbour pests, rammed earth homes have very high vermin resistance.
Durability and Moisture Resistance	Very durable. Rammed earth walls are porous in nature and may require protection from the long term effects of heavy rain or moisture. However, walls usually have good moisture resistance and generally do not require additional waterproofing in Australia.
Toxicity and Breathability	Provided surfaces are not sealed, walls are able to "breath" and are non toxic. Applying additional finishes or waterproofing additives may change this.
Environmental Impact	Harvesting of soil has minimal environmental impact when materials are sourced locally as opposed to transported quarried products. Builds usually have low to moderate embodied energy and generate little waste. Adding cement or quarried aggregate can increase the environmental impacts. The material is ultimately biodegradable.
Buildability	Soil is usually low cost, but skilled professionals can be expensive. Ramming of the earth is done in-situ on site. Good advanced planning during the building phase is required to accommodate services within the house.

Other Build Styles

Stone

Stone is one of the world's most traditional building materials. This style of home can be used to good effect where thermal mass is desired. Much like clay bricks, the stone itself is a poor to moderate insulator and less efficient on the outside wall but very effective in a well insulated envelope. To maintain comfortable living temperatures external stone walls should be well insulated from external conditions. Internal stone walls offer very good thermal mass and heat storage. Improving the effectiveness of the outer shell can be done in various ways, such as making a double stone wall with an insulated cavity in the middle, or by putting insulation over the stone (preferably on the outside) and applying a render or plaster over this.

Stone homes are highly durable and resistant to weathering. They can be labour and time intensive to build. Environmental impacts can be reduced if the stone material is sourced locally.

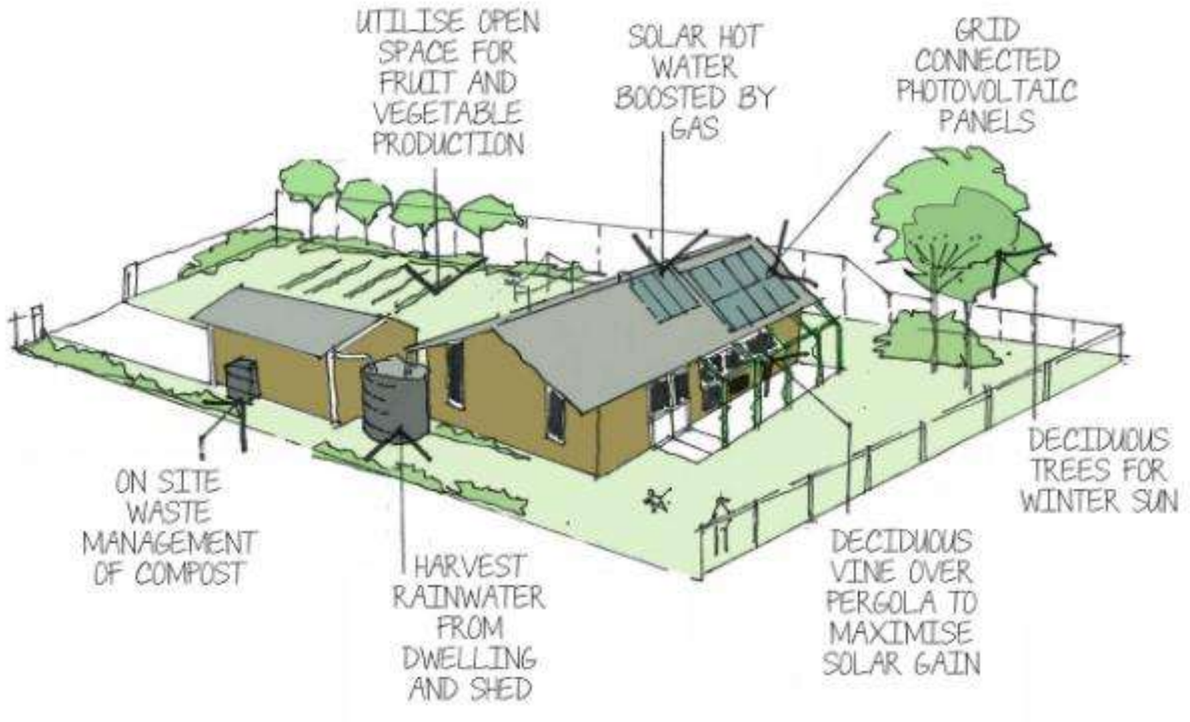
Timbercrete

Timbercrete is a masonry building brick or block consisting primarily of sawdust (timber waste) with a small amount of cement, sand and binding agents. The sawdust is a residue by-product from the timber processing industry that would otherwise be burnt or used to produce fertilisers. The product can be moulded into a variety of sizes, shapes, colours and textures for various building and landscaping applications (see Figures 28-30).

Timbercrete has low embodied energy, is lightweight with a very good insulation R-value and fire rating. The product is easy to work with and can be nailed and screwed without the need for pre-drilling.

Figure 28-30 Left–right: Timbercrete and metal clad home, Timbercrete blocks, and a reverse veneer Timbercrete build with additional clay brick structures to enhance internal thermal mass.

PART C – Checklist



Checklist

The following checklist is a basic tool to prompt discussion and planning for various aspects of building your new home.

Each item may contribute toward improving the performance of your house. The more items you can include the greater the potential to improve comfort levels, save money and reduce the environmental impact of your home. Look to strengthen areas where your response has been negative. Further information on elements highlighted within the checklist can be found in Part A of this guide.

Design		Yes /No
1	Orientate and design the home to maximise the effects of the sun and take advantage of prevailing natural breezes.	
2	Locate the main living areas on the northern side of the home to complement passive design.	
3	Minimise external wall areas especially along the east and west face.	
4	Maximise northern windows in living areas but provide suitable shade protection over summer months.	
5	Apply design features to allow for lower level winter sun to penetrate and heat living areas.	
6	Use a high thermal mass material to capture the winter sun for passive solar heating purposes.	
7	Provide suitable summer shading in the form of appropriately sized eaves and other techniques to block out unwanted sun.	
8	Use doors and windows that can be opened in summer to allow for cross ventilation.	
9	Zone living areas to reduce the demand for additional heating and cooling.	
10	Size the house to match the needs of the occupants.	
11	Use flexible design techniques to allow for changes in lifestyle and occupancy.	
12	Reduce dead spaces and areas of little use which add to operating costs and maintenance.	
13	Create outdoor living areas rather than unused rooms or spaces inside the house.	
Windows and Glazing Solutions		**Yes /No**
14	Minimise east-facing windows where possible and provide suitable shading.	
15	Reduce south-facing windows to the minimum required for lighting and ventilation purposes.	
16	Eliminate windows on the western face where possible.	
17	Use double glazing and heavy drapes and pelmets to insulate windows.	
18	Add shading options to protect windows against the hot summer sun, e.g. eaves, awnings, pergolas, shrubs.	
Insulation		**Yes /No**
19	Install ceiling, roof, wall, and floor insulation.	
20	Use the highest R-value insulation available to you.	
21	Design the roof cavity to disperse hot air.	
22	Use light coloured roofing and solar paint to reflect heat.	

23	Draught proof by sealing gaps and cracks.	
Materials		**Yes /No**
24	Avoided materials treated with hazardous chemicals and substances.	
25	Source building materials locally if possible.	
26	Consider recycled products.	
27	Avoid the use of old-growth timbers.	
28	Avoid products that release high levels of toxic gas, e.g. VOCs.	
29	Use materials that are durable and low maintenance.	
Waste		**Yes /No**
30	Use standard lengths of material to reduce off cuts.	
31	Recycle building waste on site.	
32	If possible forward waste for recycling or reuse.	
Energy and Appliances		**Yes /No**
37	Install solar thermal hot water.	
38	Group wet areas so the hot water system can be fitted close to the end purpose.	
40	Install a photovoltaic (PV) array to reduce electricity costs. (Minimise overshadowing from neighbouring structures to maximise PV and hot water performance.)	
41	Select energy (and water) efficient and size appropriate appliances.	
42	Install energy efficient lighting and avoided excessive use of down lights.	
43	Install energy efficient manual heating or cooling systems.	
Water Management		**Yes /No**
45	Install the largest available rain water tank for reuse within your budget and space allocation.	
46	Install AAA rated water devices such as shower heads, dual flush toilets and tap aerators.	
48	Where appropriate consider grey water reuse from laundry and bathing activities.	
Landscaping		**Yes /No**
49	Landscape to support passive design, e.g. summer shading and channelling of breezes for cross ventilation.	
50	Reduce requirements for watering and fertilisers by planting locally indigenous drought tolerant species.	
51	Minimise lawn area and sow low water tolerant species.	
52	Use non-fire promoting species when landscaping.	
53	Mulch garden beds to reduce run off and evaporation.	
54	Install a dripper or underground irrigation system to supply supplementary water.	
55	Plan and allow for a vegetable patch, composting site, worm farm and the provision of an external drying area for clothes.	

Resources

Information Links

Alternative Technology Association (ATA)
A leading non-for-profit organisation promoting sustainable technology and practice.
http://ata.org.au

Choice Magazine
Independent magazine and website that offers product reviews, comparisons, buying guides and advice for Australian consumers.
http://www.choice.com.au/1/index3.aspx

Environment Protection Authority (EPA) Victoria – Household grey water reuse
A Victorian Authority whose purpose is to protect, care for and improve our environment. Information is available on a number of areas including grey water. Follow links to simple tips for grey water use around the home and the EPA's Code of practice: Onsite wastewater management.
http://www.epa.vic.gov.au/water/reuse/reuse.asp

Living Green
Australian Government site, administered by the Department of Climate Change and Energy Efficiency, with information on how-to's, rebates and sustainable living.
http://www.livinggreener.gov.au

Sustainability Victoria (SV)
An agency of the Victorian Government that provides valuable resource material on various key concepts and design elements for building, as well as information on grants, funding, rebates and various sustainability programs.
http://www.sustainability.vic.gov.au/www/html/1517-home-page.asp

Sustainable Rebuilding Ideas – Complete Fact Sheets. Smart Choices for better homes.
Comprehensive series of fact sheets to help improve the energy efficiency and comfort when building a new home.
http://www.resourcesmart.vic.gov.au/documents/Sustainable_Rebuilding_Ideas_-_Complete_Fact_Sheets.pdf

Sustainable Energy Info Fact Sheets including:

Windows and Glazing Solutions
http://www.sustainability.vic.gov.au/resources/documents/Window_placement.pdf
http://www.sustainability.vic.gov.au/resources/documents/Window_protection.pdf
Insulation
http://www.sustainability.vic.gov.au/resources/documents/Insulation_types.pdf
Thermal Mass
http://www.sustainability.vic.gov.au/resources/documents/Thermal_mass.pdf
Hot water
http://www.sustainability.vic.gov.au/resources/documents/SHW_Factsheet_07.pdf

Your Home – Design for Lifestyle and the Future
Extensively used across this document, the manual and guides published by the Australian Governments Department of Climate Change and Energy Efficiency. The material offers consumer and technical guidance to promote the design, construction and renovation of comfortable, healthy and environmentally sustainable housing. It provides understanding of basic ideas and technical concepts in a simple, easy to understand format.

Your Home Technical Manual
http://www.yourhome.gov.au/technical
Your Home Renovators Guide
http://www.yourhome.gov.au/renovatorsguide
Your Home Buyers Guide
http://www.yourhome.gov.au/buyersguide

Products and Suppliers

E3 Equipment Energy Efficiency
Government site focused on improving energy efficiency of appliances and products. The site features many programs including energy rating labelling to allow consumers to compare products.
http://www.energyrating.gov.au

EcoSpecifier
Developed by the RMIT University's Centre for Design this is a guide to selection of materials on an environmentally preferred basis. The web site helps evaluate life cycles of materials and the sourcing of greener products.
http://www.ecospecifier.org

Moreland Greenlist
Provides general information on the properties of various products and construction components
http://www.sustainablesteps.com.au/pdf/Moreland_Greenlist_050905v2.0.pdf

Australian Green Procurement
A green procurement database.
http://www.greenprocurement.org/php/listCategories.php

Greenpower
Greenpower is a Government accreditation program for renewable energy generation.
http://www.greenpower.gov.au

GreenSmart
GreenSmart was established by HIA in 1999 to promote practical, affordable and durable environmental solutions for residential design and construction.
http://hia.com.au/hia/channel/builder/region/national/classification/greensmart.aspx

Green Painters
Green painters is a national initiative providing training, consumer information and skills promotion of environmentally preferable coating technology.
http://www.greenpainters.org.au

Green Plumbers
Green Plumbers is a Master Plumbers and Mechanical Services Association of Australia (MPMSAA) initiative to enhance plumbers' skills and knowledge about the environmental aspects of their work such as energy efficiency and water conservation.
http://greenplumbers.com.au

The Green Directory
Online resource for locating green business, services and products.
http://www.thegreendirectory.com.au

Water Efficiency Labelling and Standards (WELS) Scheme
Australia's water efficiency labelling scheme that allows consumers to compare products that use water.
http://www.waterrating.gov.au

Window Energy Rating Scheme (WERS)
Independently managed by the Australian Windows Associated, WERS rates the energy impact of a window across any climate in Australia.
http://www.wers.net

References

Adams, D. Accessed June 2011. *Australia - a desert and the biggest per capita user of water in the world.* http://www.newcastle.edu.au/Resources/Research%20Centres/TFI/Publications/1%20Daniel%20Adams.pdf

Atkinson, M. 2010. The Australian. ABC Carbon, *Investment in Energy Efficient Building Secures Jobs & Growth* http://abccarbon.com/investment-in-energy-efficient-buildings-secures-jobs-growth

Australian Plant Society – Wangaratta. Revised edition 2008. *It's only natural – water wise gardening in North East Victoria.*

Dept of Climate Change and Energy Efficiency. (DCCEE) *Your Home Technical Manual,* 4th Edition, 2010. Accessed Oct 2010-Sept 2011.
http://www.yourhome.gov.au/technical

Garnaut, R. 2008. 'Climate Change Review. Australian emissions in a global context'
http://www.garnautreview.org.au/chp7.html

James, C. November 30, 2009. Comsec Economic Insights, *Australian Homes are the Biggest in the World.* http://images.comsec.com.au/ipo/UploadedImages/craigjames3f6189175551497fada1a4769f74d09c.pdf

MAV, Municipal Association of Victoria, Local Government – Planning for Sustainable Buildings Guide, 2010, Accessed August 2010.
http://www.mav.asn.au/CA256C320013CB4B/Lookup/PlanningforSustainableBuildingsGuide/$file/Planning%20for%20Sustainable%20Buildings%20Guide.pdf

McDonald, S. 5 July 2010. Building Products News, *Behind the Facade.*
http://www.bpn.com.au/Article/Behind-the-fa-231-ade-reverse-brick-veneer/519938.aspx

Sustainable Energy of Victoria, June 2004, *Sustainable energy info fact sheet*, *Hydronic Heating.* Accessed June 2011. http://www.sustainability.vic.gov.au/resources/documents/Hydronic_heating.pdf

Sustainable Energy of Victoria, *Sustainable energy info fact sheet*, *Insulation Types.* Accessed July 2011. http://www.sustainability.vic.gov.au/resources/documents/Insulation_types.pdf

Sustainable Energy of Victoria, *Sustainable energy info fact sheet*, *Thermal Mass.* Accessed May 2011. http://www.sustainability.vic.gov.au/resources/documents/Thermal_mass.pdf

Sustainable Energy of Victoria, June 2004, *Sustainable energy info fact sheet*, *Window Placement and Sizing.* Accessed July 2011.
http://www.sustainability.vic.gov.au/resources/documents/Window_placement.pdf

Sustainable Energy of Victoria, *Sustainable energy info fact sheet, Window Protection*. Accessed June 2011 http://www.sustainability.vic.gov.au/resources/documents/Window_protection.pdf

Sustainability Victoria, May 2005, *Solar Hot Water,* Accessed June 2011
http://www.sustainability.vic.gov.au/resources/documents/SHW_Factsheet_07.pdf

Sustainability Victoria, July 2009. *Sustainable Rebuilding Ideas*,
http://www.resourcesmart.vic.gov.au/documents/Sustainable_Rebuilding_Ideas_-_Complete_Fact_Sheets.pdf

Todae, Accessed 9 August 2011, *Eco & LED Lighting.*
http://www.todae.com.au/LEDLighting/LED_Lighting_Guide

Notes

October 2011