INDIGO SHIRE COUNCIL

Better Build Toolkit

COMMERCIAL & COMMUNITY GUIDE

Table of Contents

Acknowledgements ii
Background ii
Introduction iii
Glossary iv
PART A – Build Elements 5
- Where to begin 6
- Pre-design 7
  - Whole-of-Life Thinking 7
  - Rating Tools 8
  - Build Styles 8
  - Existing Buildings - Improving Performance 8
- Design 9
  - Passive Solar Design 9
  - Siting and Orientation 9
  - Windows – Location, Protection, Glazing, Frames 10
  - Thermal Mass (Including Passive Heating & Cooling) 11
  - Insulation, Draught Proofing, & Air Locks 12
- Energy Management 13
  - Hot Water 13
  - Heating and Cooling 15
  - Appliances and Equipment 19
  - Lighting 20
  - Renewable Energy 21
  - Energy Procurement 22
  - Building Management Systems 22
- Waste 23
- Material Selection, Fit Out, and Indoor Air Quality 23
- Water Management 25
  - Landscape 26
  - Stormwater 26
- Swimming Pools 28
- Transport 29
- Commercial Kitchens 29
- Green Roofs and Walls 30
- Case Studies 31
  - Valhalla Winery 31
  - Charles Sturt University, Albury-Wodonga Campus 32
  - Eco Living Centre - Rural City of Wangaratta 33
  - Yackandandah Museum 34
  - Rural City of Wangaratta Performing Arts Centre 35
  - Yackandandah Primary School Redevelopment Project 36
  - 1860 Luxury Accommodation 37

PART B – Checklist & Summary 39
- Checklist 40
- Summary of Opportunities 43

Links & Resources 44
References 47

Acknowledgements

The producers of this publication would like to thank the many people involved with its evolution. In particular, members of the Indigo Shire Environmental Advisory Committee (Energy & Greenhouse Strategy Group), Brett McClelland, Kathryn McAuliffe, Peter Jones, Anton Therkildsen, Gina Bladon, Emma Fuchsen, Tatum Newton, Joost Bakker and the staff at Indigo Shire Council.

Background

The “Better Build Toolkit” is a series of four Guides designed to inform a range of developments 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.

Disclaimer: Many of the elements discussed within this document have been simplified in an attempt to provide a basic introduction to concepts and reduce the volume of information. This information guide was derived from a variety of sources and while every effort has been made to produce a useful and accurate document it may not be error free and appropriate for all particular purposes. You should verify critical information and application of design elements, products and technologies with the relevant authorities and field professionals.

Indigo Shire Council has attempted to ensure that the information contained in this guide is as accurate and up to date as possible at the time of publication. As sustainable design, construction methods and sustainable technologies is a rapidly evolving area, regular review of current best practices is encouraged. In addition, the authors have no control over the contents of websites listed and thorough research is recommended before undertaking any building construction.

Cover Photos: Front Main: Charles Sturt University, Albury-Wodonga, *rammed earth building - displaying window protection, rainwater harvesting and native planting.* Top Insert: Eco Living Centre, Wangaratta, s*olar PV tracker*. Middle and Bottom Insert: Yackandandah Primary School, *school exterior, and piping placed in the high thermal mass concrete floor during construction to supply floor heating and cooling to the school.*

Introduction

There are a number or reasons why business owners and property developers may develop a "greener" commercial or community property. Benefits may extend beyond a reduced carbon footprint, to happier staff, improved comfort levels and indoor air quality, enhanced productivity and reduced absenteeism, improved brand value, and reduced energy consumption and associated utility bills. In addition, the introduction of a carbon trading scheme and mandatory disclosure of a building's energy efficiency performance will continue to influence tenant demand and resale. Energy efficient building practices may also help streamline greenhouse emission reporting requirements.

The size, end use, budget, and scope of a commercial or a community development may vary greatly depending on what type of activity is to occur at the site. When developing a new (or looking to retrofit an existing) building an opportunity arises to make decisions that reduce adverse impacts on the built and natural environment as well as influence occupancy comfort and long term operating costs. Better levels of comfort such as natural light, greater thermal control, and low levels of background noise improve the working environment while having a positive impact on operating costs. Material selection during construction and fit out can help avoid the use of energy intensive supplies and ingredients that have a damaging effect on the environment, or have been treated by toxic chemicals.

This guide is designed to be a practical introduction to options and encourage innovation. In many cases the basic theory discussed would also prove relevant to properties undergoing renovations or retrofitting. As such, ideas should be explored further during the predesign and planning stages to assess potential for each individual application. Many energy and water saving measures can be easily implemented with a good return on investment. Others may need longer term planning, budget allocation, or require further analysis to determine feasibility.

The target audience for the guides may include those wishing to develop council and community buildings, small businesses, retail outlets, wineries, galleries, restaurants, accommodation and the like. For larger operations the content may offer some basic foundations but may require specific solutions to achieve improved outcomes. Further information can be sourced through numerous energy efficiency publications and rating tools such as NABERS and GreenStar. It is recognised that not all elements will be suitable for every development but rather different solutions will need to be considered for each unique situation. Consequently, a number of possibilities may be relevant to support business to minimise the use and maximise the reuse of resources across the building's entire life span and operation while helping create an inviting environment to operate in.

A 4.5 kW solar PV array was installed at the Wahgunyah School of Arts to help meet the electricity needs of the many community groups that use the facility.

Glossary

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 of renewable electrical energy that is fed back into the grid supply.
Geothermal Heating & Cooling	Uses a ground source heat pump and the relatively stable geothermal conditions near the Earth's surface 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 LED's relate to the use of this energy efficient lighting technology.
Off Gassing	The release of trapped gasses at normal atmospheric conditions. Referred to in this document when talking about Volatile Organic Compounds (VOC's) and the slow release of organic chemicals into the surrounding environment.
Passive Design	Climate sensitive design reduces the need for mechanical heating or cooling.
Potable Water	High quality drinking water.
PV	Photovoltaic. Technology used in solar panels for generating electricity from sunlight.
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.
Standby	(or Phantom Load) Electricity consumed by appliances while they are switched off or operating in standby mode and not performing any useful function.
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. VOC's 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

Where to begin	
1	**Commit early to energy-efficient design and plan in advance.** Successful outcomes usually stem from well researched ideas, early commitment and sound planning. The concept phase is the optimal stage to lock in energy-efficiency and sustainability as a core principle of design. For example, lot selection and building orientation can have a considerable impact on energy efficiency and operating costs. In addition, the cost of implementing sustainable design features increase as builds progress, while the ability to create a truly efficient design outcome reduces over time. *Clever ideas at the design stage can improve outcomes and pay huge dividends later on.*
2	**Do your homework. Identify relevant project consultants and understand the paper trail.** Connect with like-minded businesses, agencies, and suppliers to find out what products and materials are available, and suitable for your business environment. Learn from the experience of others and seek advice and inspiration to pinpoint opportunities and determine suitability of concepts. Understand the team and permit/application process required to progress development and achieve your goals. If conducting a building retrofit undertake a baseline assessment to determine current energy and water use patterns and identify opportunities for improvement.
3	**Write a wish list.** Prioritise each item so you can justify its importance against your budget.
4	**Prepare a budget.** Understand your expense streams and take a long-term view of costs. Think whole-of-life costing. Up to 80% of a commercial building's life-cycle costs can be associated with its operation. Therefore a key consideration is ensuring a building is designed to operate in a resource-efficient manner. An upfront investment may easily be paid back over the life of your business. Many key aspects of energy efficient projects such as good solar orientation, high levels of insulation and clever compact building design have minimal or even positive cost impacts. *Factor in long-term savings and improved resale value into your decision-making process.*
5	**Explore rebates, incentive schemes and green mortgages.** Help offset the purchase of alternative technology and investigate mortgages that offer lower interest rates for energy-efficient development.
6	**Design for the future.** Build for higher efficiency standards and in preparation for energy prices to continue to rise. The value of sustainable design is set to be a point of difference for many properties with the introduction of mandatory disclosure and when operating in a carbon constrained economy. If the current budget presents a barrier to widespread sustainable design, prioritise elements that are difficult to implement after construction, and consider provision of wiring and space to allow for an energy-efficiency retrofit at a later stage when funds allow.
7	**Ensure worker buy in.** Involve staff in the planning and development stage to create a sense of understanding and ownership for the objectives being developed. Run awareness programs and educate staff on how elements should be operated to ensure maximum benefit and comfort, and manage expectations.
8	**Monitor and review performance.** Track how elements performed during operation. This may provide important data to support implementation of additional measures, showcase techniques, assist maintenance scheduling and identify areas for improvement.

Pre-design

Consider sustainable building design early and embed concepts into plans, tender and contract documentation.

The concept of sustainable design within the built environment looks at the planning and designing of physical buildings (and services) that are socially, economically and ecologically sustainable and responsible. Sustainable development recognises that the three pillars of sustainability, commonly translated to people, profit and planet, all overlap and are interrelated. In a practical sense when it comes to building design, properties are planned and constructed to be more comfortable, safer, flexible, accessible, healthier, environmentally friendly and less resource intensive, with lower operation and maintenance costs over time.

An important factor to achieving successful outcomes in sustainable building design is securing client commitment during the pre-design phase. Embedding energy efficiency and sustainability principles early during pre-design allows for thorough planning, investigation of options and project clarity. In turn this promotes improved environmental outcomes and is usually more cost effective than retrofitting post construction.

Clients should also gain a good understanding of how to get their projects off the ground. This may include identifying which consultants may need to be engaged and determining what is involved when entering into a building contract.

Depending on the scope of the development typical consultants may include:

- Project Manager
- Architect
- Engineers – such as structural, civil, mechanical, electrical, hydraulic, fire, acoustic
- Ecologically Sustainable Design (ESD) Consultant
- Principal Certifying Authority or Building Surveyor

Whole-of-Life Thinking

Another important assessment when considering building impacts is applying “whole-of-life” thinking, which is a holistic approach to evaluating the life-cycle consequences of a building through design, construction, occupancy, refurbishment and demolition. It provides context for understanding how the initial decisions made when developing can impact the ongoing operation and deconstruction of a facility and the total financial costs over the life of the building. The aim of life-cycle costing is to support the decision-making process when developing a property and assess estimated costs of implementing features. It includes the cost of designing, procuring, operating and maintaining the system.

Key elements to consider when undertaking a whole-of-life approach to a new building may include:

- Initial investment costs such as:
    - ➢ Land, site investigation, design, materials, construction, equipment, technology and administration.
- Future expenses such as:
    - ➢ Operational costs (this is often a major component of a commercial buildings life cycle costs). *Electricity, gas, water, sewer, waste disposal, insurance.*
    - ➢ Maintenance, repairs and upgrades.
    - ➢ Residual Value. *The net worth of the asset (either positive or negative) at the end of its life*

Life-cycle management and life-cycle mapping tools can allow businesses to understand the real impacts of their processes, products and services. They can help recognise opportunities to reduce resource use and waste costs and determine the relative merit of an initiative.

Costings measured this way can provide a clearer understanding for capital outlay against operating cost incurred during the use of the building. An understanding for this approach enables businesses to better assess key environmental impacts and priorities while pinpointing major opportunities for improvement across development and operation.

Often the budget to implement energy-efficient design needs to be shielded from general discussion focused purely on construction cost savings, as the benefits are usually realised during occupancy. When considering higher cost energy savings such as double glazing and renewable technologies, life-cycle costing can be used to establish financial savings and payback periods to highlight long-term benefits and cost savings. In contrast, many other sustainable design features such as low VOC paints, water-efficient fittings and construction waste recycling generally have no additional incremental cost and can be easily supported.

Sustainability Victoria has developed two simple to use in-house, life-cycle mapping tools which may be of assistance to businesses. Refer to the link below to access these tools:

http://www.resourcesmart.vic.gov.au/for_businesses/3526_5116.html

Rating Tools

There are a number of rating and assessment tools available that allow various aspects of a building's sustainability to be quantified. Rating schemes measure energy consumption and environmental impacts and can be used to understand options and compare the environmental performance of technologies and construction systems. They can also allow informed choices to be made when defining building design and pinpointing opportunities.

Green Star

The Green Building Council of Australia (GBCA) developed the Green Star rating tool in 2002. The rating system is a whole-of-building, national, voluntary tool that evaluates the environmental design and construction of buildings and communities. The rating promotes environmental leadership and best practice when developing the built environment. Progressively a range of rating tools has become available to assess different types of buildings such as educational facilities, healthcare, industrial, office and multi-residential developments.

NABERS

NABERS (National Australian Built Environment Rating System) is a performance-based rating tool for existing buildings. It rates a building's operational impact against the environment, and compares against peers and neighbours. The range of tools is currently being expanded to cover a number of building types. The Commercial Building Disclosure (CBD) scheme requires a Building Energy Efficiency Certificate, including a NABERS Energy rating, to be disclosed when office space of more than 2000m^2 is offered for lease or sale.

Build Styles

Build styles are many and varied. Construction materials may include masonry bricks, rammed earth, straw bale, concrete, glazing, timber or metal cladding. In addition, the application of the material may vary. Such is the case with standard brick veneer and a reverse veneer building design. Materials all have differing properties that when applied in assorted ways will impact the performance of the building. When considering a construction material and build style it is important to assess design, energy efficiency and sustainability credentials, the adaptability and durability of the end product, and seek a solution that is suitable for your climate and the building's desired end purpose.

Existing Buildings - Improving Performance

Existing buildings dominate the occupied built space within the commercial sector. Largely, these properties offer numerous opportunities to improve energy use, reduce operating costs and environmental impacts.

The scale of a building's improvement may range from simple equipment upgrades and retrofits, to major plant upgrades, floor and building refurbishments or recommissioning. Regardless of the scale of the modification, property managers should consider energy efficiency with all building improvements, renovations, retrofits and as part of normal maintenance.

An important first step to help prioritise opportunities is determining the building's environmental benchmark. Measure and track the performance of the existing building in key areas such as energy and water use. Utility scorekeeping can also improve building management and utility metering by detecting errors in usage, supply or highlighting maintenance issues. In addition, undertaking an energy audit of the facility will provide property owners with potential tools and strategies to improve energy use within the building or across processes.

The majority of basic elements discussed within this guide can be applied to an existing building at some level. The cost to implement concepts will vary and the merit and application of each solution should to be evaluated on a case by case basis to determine feasibility.

Design

Passive Solar Design

Passive design recognises the sun as an energy source. Accordingly, buildings are designed for local conditions so they use less energy to heat, cool and light the property. Buildings that are constructed without giving regard to passive design principles are often less comfortable to work in and more expensive to operate. Design is targeted towards maximising heat gain during winter while restricting heat gain over summer. This is achieved through a range of features that should be considered holistically during the initial stages of development.

These features include:

- Preferred solar orientation and lot selection
- Prevailing winds
- Shading devices
- Glazing locations, types and treatment
- Insulation
- Thermal properties of construction materials

Some aspects of passive design may have little to no outlay, such as orientation, yet benefits can be appreciated immediately. Others may attract higher initial outlay but improved energy efficiency during occupation can deliver good return on investment.

To ensure comfort and success, passive design should occur in conjunction with a staff awareness program. This will assist users to correctly apply design features allowing the building to operate at its full potential. It also provides an understanding for the projected range of operating temperatures and helps manage expectations.

Siting and Orientation

Orientate and position buildings to promote solar access and support energy efficient design.

The placement of a building on a block can have an enormous impact on energy efficiency and ability to passively meet heating and cooling needs. As a result, careful lot selection and building orientation can help developers achieve energy efficiency requirements and reduce future operating costs while also supporting installations of solar technology for water heating and energy generation. In general, to obtain the best solar access for winter heating and natural lighting, locate major work areas towards the north of the building. Large glazed areas are typically fitted on northern facades to allow lower angled winter sun to penetrate and warm the building (see Figure 1). These windows will need to be protected from the harsh sun in summer by various forms of shading. Internal use of thermal mass can then be used to store warmth in winter and keep the space cool in summer.

Another consideration when positioning the building may be glare control. This may impact positioning of windows, desks and window shading to allow staff to work comfortably at desks or on computers.

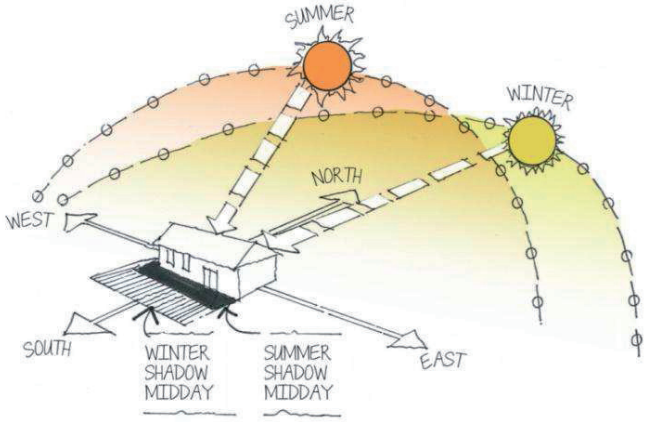


Figure 1. During winter the sun follows a lower path across the sky. Correctly size and angle shading tools like eaves so sunlight can enter the building during winter for heating purposes while being excluded over summer when it is not required.

Windows – Location, Protection, Glazing, Frames

Typically windows (and glazed door systems) are a major source of heat gain and loss. Accordingly, window placement, type and protection have a significant impact on a building's energy efficiency. Windows should be designed to consider the daily and seasonal movement of the sun. This includes encouraging solar access during winter, while restricting winter heat loss, and limiting summer heat gain. Glazing treatments such as double and low-emissivity window glazing reduce heat transmission into a building during summer, and heat loss in winter. This will lower artificial heating and cooling requirements and reduce operating costs. Double glazing can provide additional benefits such as reduced noise penetration and strengthen security measures.

> ***North Facing Windows*** – Ideally most of the windows of a building should be placed on the northern side to encourage solar access during winter. Northern windows should be designed to allow lower angled winter sun, with shading to restrict hotter summer sun penetration. Protection in the form of suitably sized eaves, pergolas, awnings, flexible louvers, or upper floor balconies should be considered to protect against summer heat gain.
>
> ***East and West Facing Windows*** – receive significant amounts of summer sunlight and can be a huge source of heat gain. Size and numbers of east and west facing windows should be kept to a minimum and well shaded with vertical systems such as external blinds, blades, or dense vegetation to reduce summer heat gain.
>
> ***South Facing Windows*** – receive very limited direct sunlight although size, type and mechanisms to reduce heat loss should still be taken into account.

The use of shading devices such as fixed over hangs, awnings and louvers can be used to manage the penetration of solar energy while still providing for good natural light. The correct selection and placement of window types and use of breezeways can also facilitate night purging of warm air during summer months to reduce the heat load on the building. Flexible entrance glazing may also achieve popular alfresco dining options for restaurants and cafes when weather permits.

Window systems, glazing and frames should be carefully considered before purchase. 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 systems are measured with a U-value. The U-value is the ability of a material to conduct heat. Table 1 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 1: Examples of window systems and the associated total heat transfer. (Source: SV, 2009)

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

In addition, the Windows Energy Rating Scheme (WERS) can be used to help consumers determine a window's energy performance. The scheme rates windows out of 5 stars. Purchase windows with a high star rating for improved efficiency and comfort levels.

For further information and to compare products go to: http://www.wers.net/

Thermal Mass (Including Passive Heating & Cooling)

Thermal mass is a material's ability to absorb, store and release heat energy. When applied correctly high levels of thermal mass can help produce a smoothing effect and stabilise comfort levels within a building. As a result occupants will not experience a wide range of fluctuating temperatures. It can act as a heat bank in winter to store and later release heat back into the building; while in summer unwanted heat energy can be absorbed by high thermal mass materials during the day and later expelled from the building by night purging.

Thermal mass is commonly used in energy-efficient design. It may appear in the form of construction materials such as masonry products and concrete, or finishes such as floor tiles. Large bodies of water such as water storage also have considerable thermal mass and can be used to absorb heat energy associated with a building. Generally, thermal mass is located in north-facing areas with good solar penetration in winter, access to cross-ventilation and exposure to any additional heating or cooling sources.

In winter, thermal mass can be used to store heat from direct sunlight (passive solar heating) or radiant heat sources. This heat is released back into the building when temperatures drop to help minimise temperature fluctuations and maintain comfort.

During summer, thermal mass surfaces should be protected from direct sunlight by shading and window coverings. Thermal mass will help lower day-time temperatures within the building by absorbing heat energy. Cooling night breezes are then used to draw out and remove any stored heat from the building overnight.

Controlled ventilation forms an important component of passive cooling. Air flow can provide a cooling effect in itself. In addition, ventilating roof spaces and night purging of hot air from a building aids passive cooling during summer. Passive (and active) heating and cooling options are discussed further under the energy management section.

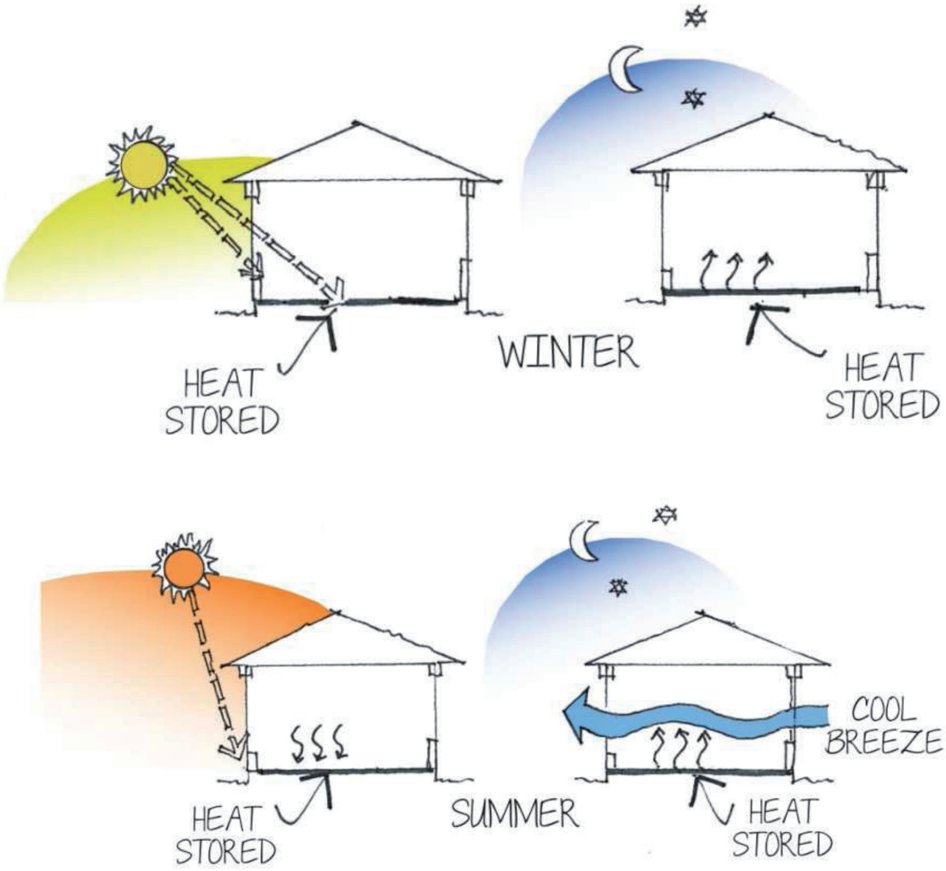


Figure 2: Seasonal use of thermal mass. The higher position of the summer sun and the use of eaves restrict heat penetration. In winter, the lower path of the sun across the sky allows for solar penetration and promotes heat storage in the high thermal mass flooring, which is later released over night to warm the building (Source: DCCEE, 2010).

Insulation, Draught Proofing, & Air Locks

Insulation is an extremely cost-effective method to strengthen energy efficiency and passive design. It can be used to restrict heat transfer in or out of buildings, improve comfort levels, reduce heating and cooling costs, discourage condensation build-up, and improve sound proofing. Building insulation is available in a number of forms. Each product is assigned an R-value which provides a measure of the resistance to heat flow. The higher the R-value the better the thermal performance and the greater the resistance to heat transfer.

When looking to improve energy efficiency across a development, maximise insulation efforts rather than simply meeting the minimum requirements.

Certain roof paints and coatings can also help prevent heat transmission during summer, thereby reducing the need for artificial cooling. These products can reduce the penetration of solar radiation and subsequently heat absorption into a building. Depending on the construction material, coatings may be an option at the time of purchase, or alternatively may be easily applied at a later date to improve building performance.

Draught proofing is also important to reduce the transfer of heat in and out of a building. There are a number of common areas that should be targeted when undertaking draught proofing in smaller buildings and community structures (see Figure 3). Also, consider fitting rollfast doors or clear plastic strips to large factory and warehouse doors to help reduce heat loss or gain.

Entrance air locks can help reduce the exchange of air. This will minimise heat gain or loss and reduce the incidence of draughts. Air locks are achieved by having a void area between two entrance doors. Self-closing doors will also reduce heat transfer which may add to heating and cooling requirements.

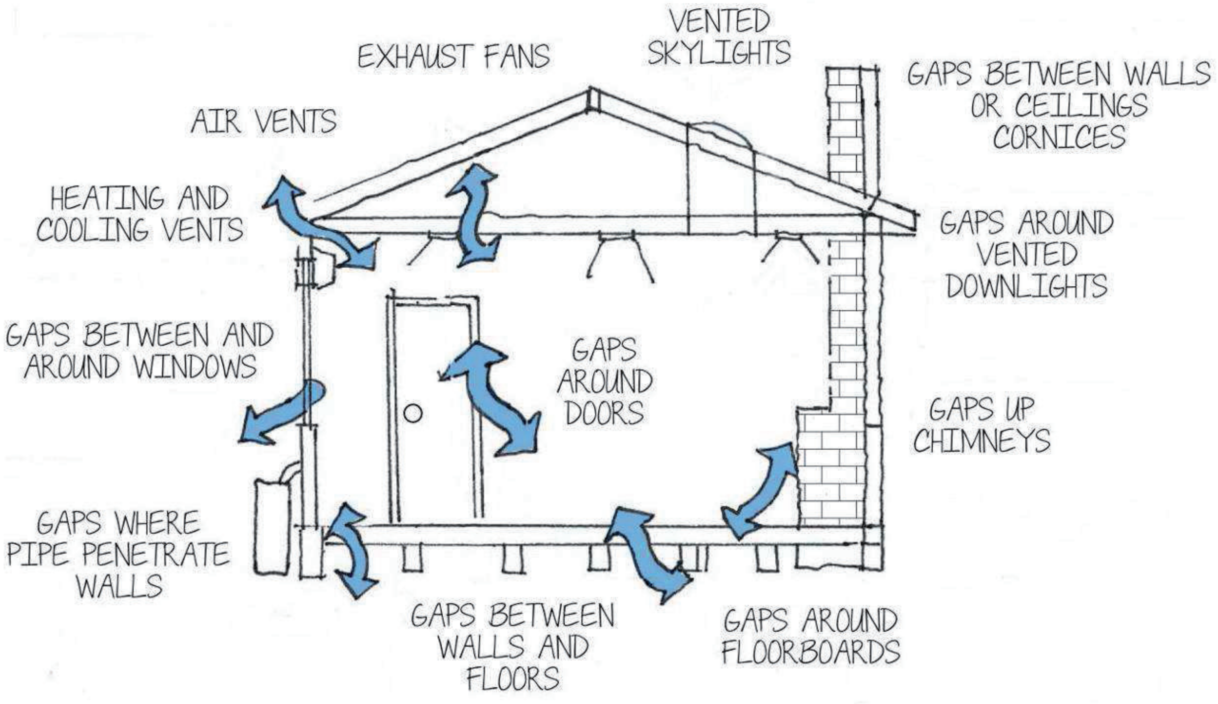


Figure 3: Typical sources of air leakage from a building (Source: DCCEE, 2010).

Energy Management

Design buildings and purchase technologies and appliances to minimise use of energy and non-renewable resources.

The total energy use at a site is a result of many different ingredients. These may include technology, user behaviour and maintenance requirements. However, there are a number of factors encouraging energy reduction. These include ever-increasing utilities costs, the introduction of mandatory disclosure for building energy efficiency, reporting against commercial or industrial activities conducted at a site, brand appeal and community expectations. As such, the implementation of efficient design, the purchase of energy-efficient appliances and educating end users on best practice makes good financial sense.

Hot Water

Hot water demand will vary depending on the particular function of the building or business. Overall cost and efficiency of the system can vary greatly depending on consumption requirements, the type of heater, fuel used to heat the water, and where the unit is installed and its delivery destination (i.e. a hot water unit may be installed some distance from where hot water is required, consequently considerable heat loss may occur in transit through pipes). Accordingly, it is very important to consider solutions appropriate to demand, climate and fuel availability.

Solar Hot Water

Solar hot water units use the sun's radiant energy to provide a hot water supply. A gas or electric booster is connected to heat the water if weather conditions are unfavourable for meeting demand. Systems are generally roof mounted, north facing, and elevated at a suitable angle to optimise solar access from the sun. The two main types of solar hot water systems are flat panel and evacuated tube collectors. Units use the sun's energy to heat water in the collectors before this water is transferred to a storage tank. If the operation uses significant amounts of hot water, a solar pre-heater connected to a more conventional system may also be a solution. Solar thermal systems for commercial or industrial applications usually have greater complexity then residential systems and require comprehensive design. To seek further information on technical, design and installation related issues for large scale solar thermal hot water systems refer to the design handbook available at:

http://www.sustainability.vic.gov.au/www/html/2867-commercial-and-industrial-solar-water-heaters.asp

This guide covers commercial and industrial installations within the 60-120˚C range, excluding swimming pool use.

Heat Pump

Heat pump hot water systems are considered a more "energy-efficient electric" option. Heat from the outside ambient air is used to heat water in a storage tank through a refrigerant and heat exchange system. Systems can be located almost anywhere and can generate a small amount of noise during operation. They are often considered as an option for locations where mains gas is not available.

Instant Hot Water

Instant hot water systems heat the water on demand. Gas fuelled systems are more economical and environmentally friendly compared to electric boost systems. Highly efficient commercial condensing systems have a secondary heat exchange configuration to help preheat water prior to calling for hot water. Instantaneous water heating systems may be a suitable option where demand is low or space or location is limited.

Combination hot water systems can be connected to a heat source to supply economical hot water. This may need to be boosted by another energy source during warmer periods of the year when the heater is not being used. Dual purpose solar hot water systems use solar hot water technology to also provide space heating and cooling. Regionally this type of arrangement has been demonstrated at Charles Sturt University, Thurgoona and Walwa Bush Nursing Hospital. Systems function by running excess hot water through pipes (hydronic heating) placed around the building. This reduces requirements for conventional heating. Excess heat can also be used to drive absorption chillers for cooling purposes. Arrangements can also be made to heat water for facilities that require pool heating.

General Hot Water Tips:

1. Always seek energy-efficient, size-appropriate solutions and look at ways of reducing the consumption of hot water with water-efficient equipment.
2. If a site is appropriate and mains gas is available, consider installing gas boosted solar hot water. For low demand consider instantaneous gas systems. Advanced alternatives may need to be considered for large demand sites.
3. Where gas boosting is not available consider electric heat pumps or electric boosted solar for small to moderate demand requirements. Fitting a timer may help target operation to specific demand periods.
4. Assess whether a combination heat source/hot water system is a viable and economic option.
5. Consider connecting a timer to any booster to restrict systems cycling to when hot water is actually required.
6. Insulate hot water pipes to reduce heat loss while water is travelling to the supply destination.
7. Wet areas should be grouped close to the supply source to minimise pipe runs and heat loss.
8. Determine if your system requires frost protection.
9. Determine if any noise generated by the system will be a problem.

Heading and Cooling

Design to reduce the demand for mechanical heating and cooling and seek energy efficient options to meet any additional requirements.

Mechanical heating or cooling needs often represent a significant portion of a property's energy bill. Accordingly, climate-sensitive design should always be the first tool to meet any building's heating and cooling requirements.

Depending on the size, use and functionality of the building, a variety of heating and cooling options may prove suitable. Methods may be passive or active or a combination of both. Refer to Table 2 on pages 17-18, for a basic introduction to options available to those developing a new facility.

Hydronic heating is the primary heating technology used in this office building at Charles Sturt University, Albury-Wodonga. Water circulated through solar panels on the roof is used to heat large underground water tanks. This stored heat can then be pumped through the slab flooring to maintain comfort.

Cooling is aided during summer by means of night purging. Louvres in office windows and the large thermal chimneys on top of the building can be opened when the outside ambient temperature is less than that inside, this allows heat exchange to occur. Windows are also protected from radiant heat gain and the thick walls and a large internal atrium helps preserve comfort levels within the building for the majority of the year.

Heating, ventilation and air-conditioning system upgrades can also be used to improve efficiency. For example, variable speed drives can modulate the frequency of voltage applied to suitable heating and cooling equipment, which can increase the efficiency of operation. Other options may include using solar thermal hot water systems to produce hot water for use in absorption chillers, rather than electricity-generated systems from non-renewable sources taken from the grid. In addition, the powering of standard fans within heating ventilation and air-conditioning systems can account for significant energy consumption as they tend to run on high a majority of the time. The installation of electronically commutated fans can reduce energy consumption due to their adjustable speed design, permanent magnets and synchronous motor.

Basic tips to help reduce additional heating and cooling needs:

1. Employ passive design elements to heat and cool the building.
    a.) Where appropriate encourage cooling breezes through the building and/or automated night purging during warmer months.
    b.) Use high levels of thermal mass within the building to store and later release heat back into the building during winter, while in summer unwanted heat energy can be absorbed by high thermal mass materials during the day and later released by means of night purges.
    c.) Use an optimal building orientation to maximise passive design and solar access.
    d.) Install high levels of insulation.
    e.) Summer shading options.
2. Choose a light coloured roof to minimise heat loading.
3. Paint roof surfaces with a reflective solar paint to reduce heat loading.
4. Draught-proof and seal gaps and cracks to restrict heat loss or gain depending on the season.
    a.) On large factory and warehouse doors fit rollfast doors or clear plastic strips to help prevent heat loss or gain.
5. Install quality glazing or thermally improve windows with solar films or temporary double glazing solutions. Installing window protection and soft furnishing can also reduce summer heat infiltration and winter heat loss.
6. Fit high levels of insulation, including ceiling, walls and floors.
7. Zone or close off sections of building to reduce the area requiring heating or cooling.
    a.) Storage rooms, toilets, passageways and warehouses may not need to be heated or cooled.
8. Match the size of any heating or cooling unit to the area concerned.
9. Use timers or programmable controllers to restrict operation to times of building use.
10. Consider the existing (or expected) heat generating sources within the building such as kitchens, computers, refrigeration and other equipment and density of occupation before determining heating and cooling requirements.

Louvre windows at Wangaratta's Performing Arts Centre are used to provide natural ventilation. The windows are connected to the Centre's heating and cooling to eliminate energy waste when open.

Table 2: Summary profile of heating and cooling options

Option	Passive Heating	Passive Cooling	Active Heating	Active Cooling	Basic Description
Atrium	X	X			Although generally associated with improving natural lighting, atriums can be used to support the collection of solar heat for distribution within a building.
Automated Natural Ventilation		X			Automated openings, often windows or louvers, to enhance natural ventilation.
Combined PV & Solar Thermal			X		Units collect solar energy. The first layer to generate electricity, the second collects residual heat for use in the building.
Earth Ducts/Thermal Labyrinth	X	X	X	X	As near surface ground temperatures are relatively stable ducts can be used to provide pre-cooling/heating of fresh air moving through the ducts.
Embedded Coils			X	X	Water coils are placed into concrete slabs to provide heating & cooling. Hot water is pumped through the coils for heating & cold water for cooling.
Ground Source Heat Pump			X	X	The thermal storage capacity of the ground is used to provide heating & cooling through a number of heat exchange options. (In addition standard heat pump systems that extract heat from the ambient air can be more efficient than conventional heating & cooling systems).
Hallowcore Slab			X	X	Thermal mass & storage capacity of the concrete slab can be used to provide a cooling effect to be distributed across the building.
Heat Recovery Ventilation	X	X	X	X	Reuses energy being exhausted from the building to pre-heat or cool incoming fresh air.
Night Purging		X		X	Variation in day & night air temperatures allow for purging of heat from a building overnight. Air flow can be via passive or mechanical methods.
OM Solar System			X	X	A proprietary system that can provide passive heating, cooling & hot water for a facility. The system uses solar collectors, PV, fans, underfloor air distribution & thermal storage.
Parabolic trough & dish collectors			X		Generally used in industrial applications, collectors are used to focus solar energy for use in heating or electricity generation.

Option	Passive Heating	Passive Cooling	Active Heating	Active Cooling	Basic Description
Passive Downdraught Evaporative Cooling (PDEC)		X			Naturally cooled evaporative air drawn through a building via down draught towers.
Passive Solar Heating	X				Solar energy is allowed to enter a building to provide heating, used with thermal mass.
Roof Spray Cooling				X	Overnight water is sprayed on the roof to boost radiant heat loss from the building. Suitable for use with thermal storage design.
Rotatory Ventilators		X		X	Wind is used to spin roof mounted ventilation systems extracting air from the building.
Shading		X			Shading a building reduces solar heat gain & reduces the need for cooling.
Solar Chimneys		X			Solar boosted high level chimneys that provide natural ventilation.
T3E			X	X	Branded system that uses solar energy & thermal energy for hot water & space heating.
Thermal Chimneys		X		X	Use static high level chimneys to provide natural ventilation
Thermal Storage – Water Tanks			X	X	Water can be used as a medium to story heat energy. Tanks should be well insulated & partially or totally buried.
Transpired Solar Air Heaters	X	X		X	Roof or wall mounted units collect & distribute solar heat across a building for heating.
Trombe Wall (Thermal Storage Walls)	X				The multilayer walls enable the collection of solar energy to be used in a building. Solar energy is transferred through the transparent outer layers & collected within the void. Heat is conducted through the heavy-weight internal wall & radiated to occupants. Double Skin Facades are similar but suited to multistorey buildings.

To explore these options (and others) further, refer to the following link. Investigate appropriate application, barriers, case studies and potential for your particular building project:

www.sustainability.vic.gov.au/resources/documents/Solar_Technologies_Report.xls

Appliances and Equipment

The purchase of appliances and equipment provides an opportunity to source products with enhanced energy efficiency. Investigate and compare the energy rating of appliances and calculate operating cost to provide an accurate approximation of expected charges. High-efficiency equipment may cost more to purchase but savings received during operation can quickly outweigh the difference in purchasing price.

Energy rating labels help buyers identify and evaluate the energy efficiency of products. “Energy Star” covers a range of commonly used office appliances such as computers, fax machines, printers, photocopiers. A number of other rating labels exist depending on the type of appliance. They are available for electricity, gas, and water consumption to help compare models and so buyers can make an informed decision.

Many appliances still consume power when they are not active or are operating in standby mode. In order to get the greatest efficiency out of electrical appliances consider the inclusion of mechanisms or standby eliminators that allow an appliance to be turned off fully when not in use. Seek equipment that has settings that allow power down or sleep mode to deploy when the machine is not in use. In addition, try to arrange for easy access switches to allow equipment to be totally deactivated when not in use.

For many businesses pump operation can be a large source of energy consumption. Seek energy efficient pump motor technology with variable speed sensors that automatically respond to load conditions. Refer to the *Energy Efficiency Best Practice Guide - Pumping Systems* for further information:

http://www.resourcesmart.vic.gov.au/documents/06-0_Pumping_Systems.pdf

When considering new appliances;

1. Study energy ratings and annual consumption data to select the most efficient model available for your needs and budget.
2. Purchase size-appropriate appliances. Bigger is not usually better and you may spend more running the appliance and not receive any usable benefit.
3. Consider the placement and housing of fridges and freezes. Protect the fridge from heat sources such as sunlight, cooking appliances, and hot external walls, which may make the unit work harder than need be. Also allow suitable area around the unit for air to circulate.
4. Consider all efficiency rating material available for an appliance. This may include energy, gas and water. Water Efficiency Labelling and Standard (WELS) rating will let you compare the water flow and water consumption rates of various products. The more stars on the label the more water efficient the appliance.

For further information on purchasing appliances and office equipment:

- ECO Buy
  http://www.ecobuy.org.au/
- Electricity and Gas rating schemes
  http://www.energyrating.gov.au/
- Energy Star
  http://www.energyrating.gov.au/programs/e3-program/high-energy-performance-standards/energy-star-australia/
- Australian Government – Environmental Purchasing (range of product purchasing and service procurement guides)
  http://www.environment.gov.au/sustainability/government/purchasing/
- WELS
  http://www.waterrating.gov.au/

In addition, voltage optimisation devices may provide a method for further reduction in energy consumption. These systems are typically installed to a buildings mains electrical supply. They may provide a reduced voltage to equipment depending on a site’s power demand. A facility should be analysed to determine the benefit of such technology as electrical load type can affect commercial benefit. Businesses which have higher inductive loads, as experienced with motor and pump operation tend to achieve greater energy savings.

Lighting

Effective lighting is a fundamental element for any space. A combination of factors will need to be considered to determine requirements. These may include visual comfort, natural lighting, energy efficiency, control and flexibility, and task. Energy-efficient design options attempt to maximise natural lighting without creating a pathway for undesired heat loss or gain and use energy-efficient technology to meet any artificial lighting requirements.

Careful placement and design of skylights may add to natural lighting without allowing heat gain or loss. Energy-efficient globes and fittings can be used to provide artificial lighting. Motion sensors, dimmer switches, timers and automatic deactivation switches can also help reduce energy consumption. In addition, design should match lighting to purpose so that tasks receive correct levels of illumination. For example, downlights are designed to be used as a spot or task light and as such generally are not economic or ideal for broad room lighting. The placement of light switches is also important to allow for easy access and encourage controls to be turned off when not in use.

Design features that support the penetration of natural light into a building include:

- ✓ ***Light Shelves*** - Light shelves deflect light to improve dispersion of natural light and reduce the need for article lighting.
- ✓ ***Atrium*** - An atrium is used to provide a thermal buffer against external conditions and to increase the amount of natural light into a building.
- ✓ ***Anidolic Ceilings*** - Are used to improve the penetration of natural light into a building.
- ✓ ***Daylight Dimming*** - Daylight dimming adjusts levels of artificial lighting output in response to available natural light to reduce energy consumption.
- ✓ ***ETFE Coil Cushions*** - An alternative to standard glazing systems can allow improved areas of transparency and penetration of natural light without reducing the thermal performance of the building.

Please also refer to the following Sustainability Victoria link for further information including examples, appropriate application, indicative cost and energy savings, construction impact and barriers;

www.sustainability.vic.gov.au/resources/documents/Solar_Technologies_Report.xls

The type and range of energy efficient lighting technology is rapidly changing. Evaluate cost, technology and task requirements before purchasing artificial technology. Options include:

LED (light emitting diode)
LED globes are very energy efficient, have good brightness and don't contain mercury. They have long life expectancy, give off very little heat while in operation, and have high light efficacy. The range of LED options is fast increasing and while purchase prices are still relatively high this is changing.

Compact fluorescent (CF)
Compact fluorescent globes can be a little bigger than existing fittings, contain mercury and depending on the technology are sometimes slow to warm to full brightness. They have lower running costs than traditional incandescent bulbs and are available in a range of sizes and fittings.

Fluorescents lamps
Fluorescent lamps or tubes have improved energy efficiency and are longer lasting than standard lighting. They are widely used in commercial and institutional facilities with extensive lighting requirements.

Incandescent lamps are the least energy efficient type of lighting. They are inexpensive to buy, however, almost all of the electrical energy used by incandescent lamps is converted into heat rather than light and running costs can be high. Incandescent bulbs are available in a wide range of shapes and sizes, but do not last as long as other light technology. Halogen lights are also a type of incandescent lamp. Low voltage halogen lamps (commonly known as downlights) are not low energy lamps. While they are slightly more efficient than standard incandescent lamps of the same wattage, the light beam is reduced. Large numbers of low voltage halogen lamps are often fitted to light large spaces. This is an inefficient way of lighting a room and results in unnecessary energy consumption both through the lights themselves and the heat loss due to the holes in the ceiling and gaps in insulation.

Renewable Energy

Onsite electricity generation can help reduce costs associated with purchasing electricity from the grid. In addition, installing a renewable energy system is an effective way of reducing a facility's total greenhouse gas emissions. The suitability of any technology should be fully assessed for each unique site to determine viability.

Solar Power

Businesses may be able to use photovoltaic (PV) solar panels to generate electricity to meet some or all of their needs. Systems can be small to provide for a single consumer or larger solar "parks" or "farms" can be used to supply many users or a greater component of a facility's energy needs. Excess power not used at the time of generation may be fed back into the grid and attract a tariff. Panels are often roof mounted and should be positioned to optimise solar access with a suitable pitch and northerly orientation. Unshaded surfaces are preferable. Arrays can be fitted to frames at ground level if space provides. Solar tracking systems are available that allow the panels to follow the path of the sun across the sky to maximise solar benefit. Alternative solar power technology includes PV glazing panels. In this case PV cells are mounted between two panes of glass within a laminate glazing system.

A 4.94 kW solar PV array was installed at Kiewa Bowls Club, Tangambalanga in June 2012. The system will be used to reduce consumption of grid electricity for Coulston Park user groups.

Cogeneration/Trigeneration

Cogeneration is the production of two forms of energy, electricity and thermal, from the one process. For example, heat (thermal) energy is produced as a by-product from the generation of electricity. Typically the heat is seen as a waste product and released into the atmosphere, for instance, via cooling towers and flue gas. Cogeneration facilities capture this heat energy and reuse it in other industrial or domestic processes or for space or water heating. Using cogeneration can improve the efficiency of many electricity generation processes and can provide significant financial saving for both the consumer and supplier.

Trigeneration refers to the combined generation of useful cooling, heating and power from the combustion of a single common fuel or solar heat collector.

A variety of fuels can be used with this technology such as coal, petroleum products, natural gas, biomass and biogas. Generally these systems require constant energy and heat demand to be feasible and are most attractive to sites that have large electricity, heating and cooling needs. Accordingly, this sort of system may be more appealing to larger commercial, industrial, manufacturing, educational and health care facilities.

Biomass energy

Biomass is plant and animal matter used to generate electricity. Garbage, wood, waste, landfill gases, crop waste and alcohol fuels can all be used to generate biomass energy directly or converted into other source of energy such as biofuels or heat. Biomass can act as a supply of chemical energy generated from solar energy through the process of photosynthesis. This type of energy is called bioenergy. When biomass is burned, energy is released in the form of heat. In the natural state the organic material would break down slowly and release stores of carbon dioxide back into the atmosphere. By burning the biomass, energy is converted in a similar way to nature but at a faster rate and the store of energy can be captured and used. Providing that biomass is not burned faster than it can be created it is considered a renewable form of energy.

Biomass can be used directly to heat or to meet specific purposes such as cooking, for example wood. Alternatively, biomass can also be used indirectly when converted to fuels such as liquids or gas. Methane or natural gas from manures, and biofuels such as ethanol from sugar cane are some examples of this. When determining the feasibility for biomass use at a site, consideration should include biomass resource type, availability and consistency of biomass delivery.

Energy Procurement

When purchasing energy you can choose from a range of sources with differing costs and greenhouse gas emissions. For example gas is generally cheaper and emits substantially less greenhouse gases then electricity generated from coal-fired stations. In contrast, electricity generation from renewable sources produces considerably fewer or no greenhouse gas emissions.

Green Power

Green Power is energy generated from a renewable energy source such as hydro, wind, biomass, and solar. This is usually available on request from power suppliers and may have a premium tariff attached to it. Green Power can present many benefits to business such as offering a mechanism to help reduce greenhouse gas emissions, representing the business's commitment to sustainability, improving the business profile, and supporting a business to meet environmental reporting obligations. Additionally, Green Power allows buyers to support the development and use of the renewable energy industry. However, the greatest priority for reducing energy procurement costs starts with implementing energy-efficiency measures and decreasing onsite consumption.

For further information regarding Green Power and accredited programs refer to: www.greenpower.com.au

Building Management Systems

Good design and appliance selection may be only part of the solution for improving the energy efficiency of a building or complex. The inclusion of Building Management System (BMS) software and hardware can be a significant component in controlling energy demand. A computer-based control provides a centralised (and remote) system to monitor, regulate and optimise a building's internal environment. Systems linked to a BMS typically include mechanical and electrical equipment such as ventilation, lighting, heating and cooling, power systems, fire systems, and security systems. All of which can represent a significant percentage of a facility's energy usage. These systems can also be used to manage water consumption.

Such systems can offer a number of benefits. They include:

- Effective monitoring, targeting, and identification of unusual patterns of energy consumption
- Good control over internal comfort levels
- Improved plant reliability and life
- Streamlined maintenance scheduling
- Early fault identification
- Reduced complaints
- Remote access, such as to deactivate accidental energy waste

Building Management Systems are used and demonstrated regionally at the Wangaratta Performing Arts Centre and Charles Sturt University, Albury-Wodonga. For more information refer to:

http://www.climatechange.gov.au/government/initiatives/eego/~/media/publications/eego/BMS-guide-pdg.pdf

Waste

Minimise energy and material waste across the building's entire lifecycle from building development, occupation, through to demolition or reuse.

Increased pressure is placed on landfill facilities through population growth. As such, minimising waste should be a focus at every site and systems should be put in place to promote recovery and reuse of waste material. Provisions can be made during construction and then occupation to encourage waste to be easily separated, stored and collected. Incentives may be included in the tendering process to ensure that contractors minimise material use and maximise recycling of construction waste. In addition, clear signage and locating waste separation stations in high use areas will encourage the correct disposal of waste during use.

Tips to reduce the generation of waste to landfill include:

1. Accurately calculate materials to avoid over ordering. Establish a return policy for excess material if possible.
2. Carefully store materials onsite to avoid weathering and damage.
3. Identify what recycle and reuse options are available locally and offer a second life to discarded products and materials.
4. Integrate waste separation stations into initial building designs and situate close to point of use to encourage correct disposal.
5. Prepare for the disposal of onsite green waste. Can it be composted on site and/or worm farms installed for the processing of food scraps and garden waste, to support soil conditioning?

For further information on how to minimise construction and demolition waste refer to:
http://www.sustainability.vic.gov.au/www/html/1940-how-to-minimise-construction--demolition-waste.asp?intSiteID=4

To audit recycling and reuse in your existing workplace refer to:
http://www.resourcesmart.vic.gov.au/documents/Recycling_and_reusing_in_your_workplace.pdf

A compost bin located in staff lunch rooms can be used to process organic waste. This system produces a liquid fertiliser for further use.

Clearly labelled bin systems encourage the correct disposal of waste.

Material Selection, Fit Out, and Indoor Air Quality

Select materials that have low environmental and health impact.

Selection of construction materials and property fit out allows developers to avoid purchase of environmentally damaging products or goods that may have a detrimental impact on the working environment. A number of factors may need to be considered as environmental impact and health and wellbeing can often compete against durability, suitability, availability and cost. Check the environmental certification of products and seek materials with low embodied energy, high recycled content or salvaged items. To help establish a healthy working environment and preserve indoor air quality select non-toxic, low VOC (volatile organic compound) finishes, flooring and materials such as paints, carpets, wood products, insulation products, piping, particle board and adhesives. Where possible avoid CCA (Copper Chrome Arsenic) treated, rainforest or other unsustainable timbers.

When evaluating materials consider:

- Is the material locally sourced?
- Is the material renewable or from a sustainable source?
- Can the product be recycled at the end of life?
- Is the material harmful to the atmosphere or work environment?
- Does the product have high recycled content?
- Will the product significantly improve energy efficiency?
- Does the material have low embodied energy?
- If renovating or retrofitting can any existing materials be reused?
- Is the product durable, with low maintenance?
- Does material selection and eventual disposal align with company commitments to programs such as EcoBuy or Wastewise?

As many of these aspects may oppose each other, careful consideration will be needed of impact versus benefit. Where possible, always try and source the most environmentally friendly version of each material compared to the standard product.

Indoor plants can significantly improve our working environment in a variety of ways. Plants can soften the built environment and add a sense of tranquillity while providing many health benefits. They can clean the air, reduce noise, lower stress, and improve business image. Indoor air pollutants can be considerably higher than the outdoor environment. Plants in the workplace can offer a natural and effective way to reduce air pollution and VOCs being emitted from fittings and furnishings. They can also reduce the incidence of sick building syndrome.

Water Management

Maximise water conservation by considering and managing water as a limited resource during pre-design planning, building construction, occupation, and while undertaking regular maintenance.

Water consumption in commercial buildings may only comprise a fairly small component of the total national water usage and yet by implementing simple measures significant reductions in usage can be achieved. Not only can this help conserve a precious resource it will lower water charges for the site and benefit the bottom line.

The main user of water in a commercial building is often amenities. Select water-efficient fixtures and appliances. The WELS (Water Efficient Labelling and Standards Scheme) provides information on the water consumption of various products. Look for appliances with higher star ratings.

When fitting out toilets, kitchens, bathroom, and laundries consider the following water management tips:

- Toilets – dual flush toilets, low water or waterless urinals
- Low flow showerheads and tap fittings
- Flow controllers
- Water efficient dishwashers and washing machines
- Consider the reuse of wastewater on site

For existing buildings also consider conducting a water audit to identify opportunities and promptly report and fix leaks. Consider water efficiency with any new purchase of appliances, review processes and activities to spot inefficient practices and ensure regular inspection and suitable maintenance programs are in place for equipment. For example, inspections and maintenance may provide an opportunity to reduce water loss through evaporation, leaks, bleed rates and water treatment.

To determine water requirements and options for industry and manufacturing, review whether a particular process or activity is necessary and then determine reduction solutions and suitable water sources. In addition, establish if waste water can be treated, filtered, and reused on site, or recycled for use elsewhere.

A waterless composting toilet at Charles Sturt University, Albury-Wodonga. Wodonga.

Mains reticulated drinking water has been treated to a high level in order to be suitable for human consumption. In many cases this level of treatment is not required for many purposes across a facility and water-sensitive building design can significantly reduce demand. Rainwater runoff is a valuable natural resource that can be captured in tanks and/or used for a number of other purposes across a site and help reduce water bills.

By installing collection equipment such as tanks, rainwater can be used for tasks such as toilet flushing, irrigation and washing. First flush devices are also available commercially that diverts the first flush and hence helps remove contaminants from rooftop collection such as dust, birds droppings.

Helpful links for rain water tank design include;

A quick reference guide to rain water tank design principles
http://www.clearwater.asn.au/sites/clearwater.asn.au/files/resources/A3%20Rainwater%20Tanks%20Quick%20Reference%20Guide.pdf

The Tankulator – A free online tool which helps determine what size rainwater tank best suits your needs.
http://tankulator.ata.org.au/index.php

Water from this tank installed at Indigo Shire Council's Yackandandah depot is used to clean machinery.

Where appropriate consider the reuse of wastewater on-site. There may be many opportunities to avoid using "potable" high quality water when wastewater may meet the need. Grey water can be treated on-site in a number of ways, such as by treatment ponds and reed beds. This can then be recirculated for further use, to provide amenity, toilet flushing, garden irrigation, or be available as part of a fire management strategy.

Landscape

Landscape to enhance passive design, amenity, and biodiversity, while considering water conservation and the impacts of stormwater.

Landscaping can meet a number of purposes across a facility such as adding appeal to a building, providing shade and supporting passive design, channelling cooling breezes, acting as wind breaks and reducing run off.

When designing the outdoor space around your buildings implement water-sensitive design and consider the following tips to reduce water requirements:

- ✓ Select low water, drought tolerant plants and locally indigenous species (check suitability of species where bush fire protection is a priority).
- ✓ Use mulch to reduce the evaporation of water from the soil.
- ✓ Install soil moisture sensors.
- ✓ Use drip irrigation systems with timers to water gardens at times when there is low evaporation.

Stormwater

When developing a site, design features can be implemented to reduce the impact of stormwater. Aim to reduce the amount of stormwater flowing off-site into the existing stormwater system, and explore options for reuse and ways of improving runoff water quality. Attempt to maximise filtration, storage, and infiltration, to decrease water flow off-site.

Reduce the extent of impervious surfaces that may retard water penetration. Limit the clearance of vegetated areas and where possible consider porous surfaces for footpaths, pavements, car park areas, outdoor areas and patios. Materials such as loose aggregate, well-spaced paving, gravel, and wooden decking may aid filtration.

Stormwater management includes the temporary storage or retention of surface run-off which can later be released at a reduced rate into a receiving water supply. Depending on the individual situation there are a number of alternatives available including:

- ***Rainwater Tanks***
  A variety of sizes and materials are available to act as rainwater tanks to store building run-off. This water can be released back into the existing stormwater system or reused on site to significantly reduce potable water usage.

- ***Green Roofing***
  Green roofs have a varying soil depth, usually between 5cm and 15cm. Roof gardens will need a water-proof membrane or liner, and will require the roof to have suitable load-bearing capacity to support the feature and its potential water storage. Green roofing can also improve the building's energy efficiency.

- ***Rain Gardens***
  An engineered bio-retention garden designed to regulate the flow of stormwater. Rainwater falls or flows into the garden bed and then moves through a planted filter medium. Rain Gardens can improve the quality of the water flowing back into the stormwater system and reduce the potable water requirement for the planted area while providing a greener prospect to the streetscape. For further information refer to "*Raingarden design principles".*
  http://www.clearwater.asn.au/sites/clearwater.asn.au/files/resources/A3%20Raingarden%20Quick%20Reference%20Guide_0.pdf

- ***Stormwater Retention Basin***
  An engineered retention basin designed to manage large stormwater flows. These structures act as a buffer for downstream catchments by releasing excessive stormwater in a controlled manner. They also commence the stormwater treatment process by holding the water for extended periods to allow any suspended sediment to settle to the bottom. These basins can also be used to provide water for reuse on surrounding areas thus reducing the reliance on potable water.

- ***Bio-Filter/Vegetated Swales***
  A form of bio-retention where open channels are covered in vegetation, usually grasses. Run-off is redirected to the swales during a storm event. Swales are also effective in improving water quality and removing pollutants from the stormwater. For more information refer to "*A quick guide to bio-filter swale design principles".*
  http://www.clearwater.asn.au/sites/clearwater.asn.au/files/resources/A3%20Swale%20Quick%20Reference%20Guide.pdf

The treatment pond above is part of the Havelock Rd Stormwater Management System in Beechworth. It is one of four interconnecting ponds that form a wetland. The treatment wetland is designed to improve water quality by giving nutrient or sediment-laden stormwater run-off a long, slow path through a densely planted environment before being discharged into the waterway.

Swimming Pools

Some properties will offer swimming pools or spas as part of their business. While this can offer recreational enjoyment, exercise and summer relief; pools are usually energy and water intensive to operate. The size, location, design, range of facilities and equipment managing the pool will influence energy, chemical and water consumption. While there is no "one size fits all" solution to reduce the environmental impact of a pool, there are a number of things you can consider to improve efficiency and pool performance.

Top tips for managing your pool or spa:

1. Situate the pool to minimise evaporation and save on heating costs.
   a.) A well-designed wind break can help reduce wind speed across the water thus decreasing evaporation and heat loss.
   b.) Position the pool to receive direct sun light resulting in natural heating.
2. Install a pool cover to save water and energy, reduce maintenance and retain heat.
   a.) A variety of covers exists, such as, bubble, thermal, liquid and slat covers.
3. Equip the pool or spa with the most energy efficient pump, filtration, and cleaning systems.
   a.) Variable speed motors, automatic controllers and timers may also improve efficiency.
   b.) In addition, floating water ionisers may help reduce chemical and pumping needs by purifying the water through a process of ionisation. They are solar powered and low maintenance.
4. Monitor water levels to ensure the pool has not developed a leak.
5. If heating is necessary, source energy efficient options and use equipment to retain as much heat as possible between uses.
   a.) Consider solar heating in conjunction with a pool blanket.
6. Conduct regular maintenance on the pool and associated equipment to ensure everything is operating to full efficiency.
7. Install water storage such as water tanks to supply pool top ups rather than relying on mains water.
8. Look to improve water and energy efficiencies for all supporting buildings. This may include energy- efficient lighting, kiosk equipment, solar hot water to shower blocks, low flow showerheads, tap aerators, stop taps and dual flush toilets.

Transport

Facilities can also impact the environment through staff and patron vehicle use. The development of a site can provide an opportunity to encourage the use of carpooling, public transport, cycling and alternative modes of transport. This can be achieved by providing trail networks, preferential parking, secure storage and change facilities for cyclists, and charge points for electric vehicles. Having change and showering facilities also encourages lunchtime and pre and post work activities to support staff health and wellbeing.

Providing bicycle racks and lockers for cycling equipment supports healthy lifestyle choices, is cheaper than driving and reduces the use of fuels to operate motor vehicles.

The selection of fuel-efficient vehicles and machinery for work activities, including models with dual fuel, hybrid or electric engines, represents another opportunity to reduce environmental impacts resulting from transportation. Also ensure vehicles are size and purpose appropriate for their end use.

Commercial Kitchens

Food preparation and storage can represent a large proportion of a commercial kitchen's energy and water consumption. When planning, installing or retrofitting a commercial kitchen, improve energy and water efficiency by completing the following:

- Eliminate standby time on fryers, boilers, steamers, etc.
- Choose size and use appropriate appliances and investigate energy efficiency settings for operation. Look for energy and water efficient models of refrigerators, freezers, dishwashers, etc.
- Consider variable speed exhaust fans that can be regulated depending on demand.
- Think about whether a heat recovery system be used to capture, transfer, and reuse waste heat for another purpose. For example, waste heat from sources such as cooking, exhaust ventilation, ambient air and cooling systems can be used to preheat incoming water through a number of different technologies.

Also consider integrated waste separation systems to allow for appropriate waste disposal and encourage composting and organic waste reuse. Explore low water sanitation and cleaning systems that reduce the need and use of costly and potentially harmful chemicals.

Green Roofs and Walls

This concept uses living vegetation to help improve a building's performance. A green roof may be either flat or pitched. It is fitted with a water proof membrane, and has a growing medium which can be partially or fully planted out with a variety of different species.

Roofs can be constructed to cater for lighter, shallow growing species, or heavier, more intensive vegetation, which gives a more substantial effect. As such, green roofs can be planted as a lawn, a manicured garden, or even a dense forest.

Green walls may be external or internal vertical fixtures which support vegetation in either a stacked pot array or growing mats. Green walls can also be integrated into the cooling strategy of the building and/or the water treatment system.

Green roofs and walls offer a number of performance benefits in addition to improving building aesthetics and landscaping efforts.

These can include:

- Enhanced sound and thermal insulation.
- Reduced heating and cooling needs.
- Decreased stormwater run-off.
- Improved air quality.
- Longer roof lifespan.
- Conservation and improved biodiversity.

Green roofs and walls may also present an opportunity for food production for use in the work place.

Furthermore by lowering the ambient roof temperature, green roofs can enable solar (PV) panels mounted over them to work more effectively.

A vertical green wall of pot plants has been externally fitted to this building. It reduces radiant heat gain, improves insulation and in this case even provides produce.

Case Studies

Regionally a number of projects have been completed that showcase a variety of energy-efficient builds and retrofits. The budgets, scope, motivation and end use for these ventures may contrast greatly, but all provide an opportunity to see what can be achieved with forward planning and a desire to reduce operating costs and the impact on our environment.

Valhalla Winery

A number of energy-efficiency elements were included when developing the Valhalla winery in 2007. The building uses solar passive design principles and features one metre thick jumbo straw bales in the construction of load bearing walls. These bales are estimated to have an R18 insulation factor. Aircell and blanket insulation was installed in the roof. A lime and sand render was applied to the walls and double glazed windows fitted. Up to 120,000L of rainwater can be captured from the roof run-off and is used across the winery and its grounds. In addition, an A & A Worm Farm waste system was connected to process all of the waste from the cellar door and toilets. Winery wastewater goes through a five-point settling system prior to dispersal over a native tree plantation.

The owners chose to use straw bale as a building material for a number of reasons. It fitted well with their focus on sustainability being a material that is renewable and clean. The insulation properties of straw bales are exceptional. They have found over the past few years that the building maintains a comfortable even temperature year round with minimal need for additional heating or cooling within the winery. Finally, the finished walls look great.

The building process itself was a great learning experience, being the first time the owners had built with straw bales. This led to them building their own home using similar philosophies and straw bales during 2011. One of the greatest findings from the experience was that very even temperatures can be maintained inside the winery, despite a fluctuating outside environment. An additional advantage has been the interest within the community to come and see and experience a straw bale building. Following a sustainable building philosophy has allowed Valhalla to showcase how they operate within a set of principles which has provided them with a distinct point of difference within the winery tourism market.

In a testament to this approach the winery won the Environmental Sustainability Award at the 2012 Fed Square "Best of the Best" Wine Awards in Melbourne. The award recognises the winery's commitment to sustainable vineyard and winemaking practices.

For further information contact
http://valhallawines.com.au/

Valhalla Winery, Wahgunyah, was constructed in 2007 from jumbo straw bales. After the bales were laid, 3 coats of lime render mix were pumped onto the surface to protect the bales. The design includes many passive design and sustainability features.

Charles Sturt University, Albury-Wodonga Campus

Charles Sturt University's Albury-Wodonga Campus has incorporated into its buildings and grounds numerous sustainable design elements. The success of this has made the campus a national and international champion for sustainability.

The Rammed Earth Buildings

This rammed earth office building has walls constructed by compressing a wet mix of natural materials into a frame. This delivers walls that are durable with high thermal mass.

These buildings rely on the mass of wall thickness to protect the indoor environment from outside temperatures. Large central atrium spaces in the buildings act as heat or cool banks of air. Heating of these buildings is primarily achieved using solar panels that heat large underground water tanks. The heated water is continuously circulated through piping in the building's floor slab. On exceptionally cold days small gas boilers boost the hydronic heating to maintain comfort.

In summer, cooling is predominantly accomplished by purging hot air from the buildings at night. Louvres under each window and the thermal chimneys open up once the outside ambient temperature is less than that inside. Natural convection currents proceed to draw the heat out of the building. The combination of thick walls and large air space maintains cooler temperatures through the bulk of the day. As a result, supplementary cooling can be limited to extreme heat days.

In addition to the heating and cooling, these buildings also have dry compost toilets and hence water usage is very low. What water is used makes its way to on-site grey water ponds that clean the water and allow it to re-enter the water table, or be used for on-site irrigation.

Phase Change Materials (PCM)

A phase change wax product has been embedded into the walls and floor of this office building. The material absorbs and later releases heat to modulate changes in temperature.

The most recent office building at the campus incorporates the passive design elements such as heated floor slabs, large atrium and night purging. In contrast to the thick rammed earth walls, this building has lightweight and highly insulated walls. Additionally, it has become the first building in Australia to use Phase Change Materials (PCMs). These are tiny wax capsules embedded into the wall linings and in a screed under the office carpets. During summer, the wax melts at 22 degrees Celsius and this change of state from solid to liquid absorbs heat from the room, maintaining the temperature at 22 degrees. The night purge resets the wax. A small cooling tower is used to supplement cooling of the floor slab on excessively hot days.

Working with the buildings

An important aspect of the passive buildings operating on campus is that occupants must work with them. Each office is provided with operable windows and ceiling fans. Staff are encouraged to dress for the season and even adjust their hours of work to suit their comfort levels within the building. While this may be perceived as a drawback, the occupants enjoy the fact that their buildings are fresh and they can control their comfort levels.

The New Commercial Buildings

The campus has several new commercial buildings which have incorporated numerous sustainable design elements. The buildings include the Learning Commons which features a library and offices, the Dental Clinic, an Early Learning Centre and the main Learning & Teaching building. Sustainable design elements include but are not limited to the site aspect to get maximum benefit from sun and shade, building management systems and sub-metering to ensure maximum efficiencies, stormwater reuse, waterless urinals, low impact construction materials and solar hot water systems.

Working with the site

The campus sits on 87ha of previously weed-infested paddocks. CSU used the natural slopes and features of the site and placed the buildings in such a manner that natural contours could be used for maximum benefit. Rather than rush stormwater off the site there are numerous low flow swales that meander across the campus, slowing and cleaning water. Grey water is piped to ponds that filter this waste water. Both forms of water divert into large holding ponds from which water can be harvested for irrigation. These ponds, now called the David Mitchell Wetlands, support hundreds of bird species and other native animals. A solar powered pump and windmill are used to transfer irrigation water across campus. Other site management elements are crash grazing, over slashing and poisoning, allowing natural grasses to choke out the weeds and recycled gravel paths over concrete.

The public can drive and walk through the campus for an outside view. Further information can also be found at the following sites:

http://news.csu.edu.au/uploads/documents/Campus%20Briefing%20Notes.pdf

http://www.rivertime.org/lindsay/ar_articles/ar_73.pdf

http://news.csu.edu.au/uploads/documents/Briefing%20on%20Building%20AA3.pdf

Eco Living Centre - Rural City of Wangaratta

The Eco Living Sustainable Communities Project is an initiative of the Rural City of Wangaratta and has been made possible by a grant through Sustainability Victoria's Sustainability Fund. This project aims to provide ongoing community education, provision of sustainability demonstrations and workshops at a key community location.

The HP Barr Reserve Community Centre was chosen for the Eco Living Centre located in a high profile area and next to a high use community facility. The Centre acts as a demonstration of what can be done in households and community buildings to become more sustainable.

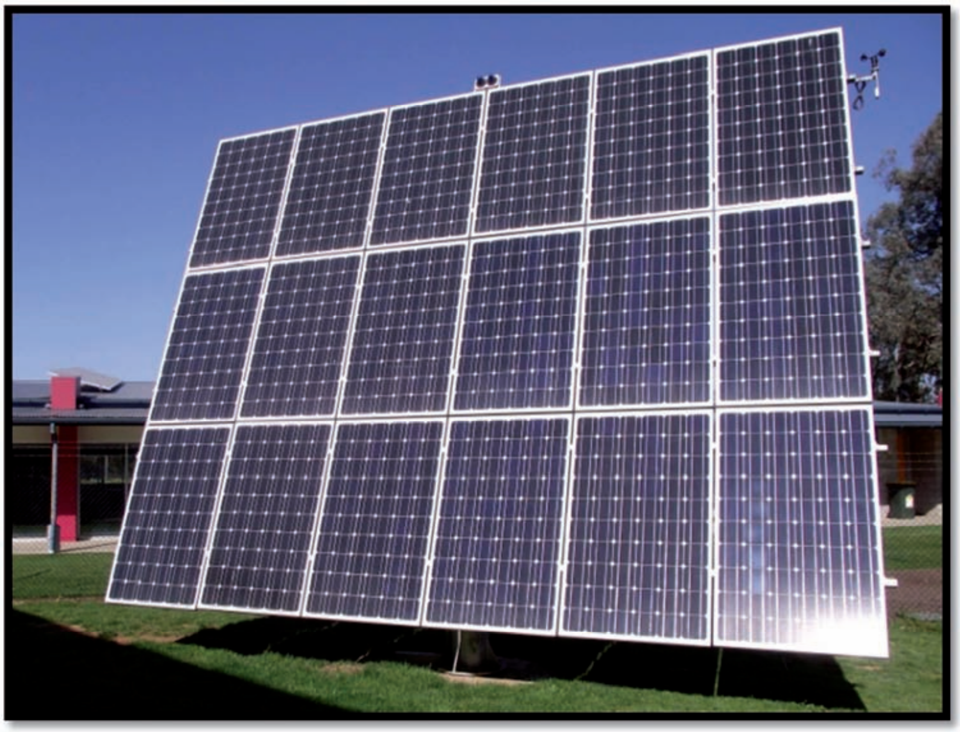
Before any works were carried out, a NABERS Green Star assessment was completed to determine the buildings existing rating and recommendations were presented on how the Centre could improve its efficiency and sustainability. Another assessment will be carried out once all of the retrofits have been fully completed to verify the success of the improvements.

Retrofits to the centre include:

- Installation of a tracking solar PV and fixed solar PV cells providing power to the Community Centre. These two systems are the same size and are being compared for their power generation.
- Installation of evacuated tube solar hot water.
- Garbage and recycling was implemented into the Community Centre along with organics recycling for Centre users and the Sports Centre cafe.
- A lighting display to compare different types of down light including halogen, compact fluorescent and LEDs. When each type of down light is turned on, a display shows the cost of running, power consumption and emissions produced for that particular light source.
- Interpretative signage in and around the Centre to explain features of household sustainability.
- An additional water tank was installed for the Community Centre and HP Barr Reserve. The 221,000L tank adds to the two existing tanks used for watering the sports ovals. Water is sourced from stormwater, pool backwash water, bore water, and river water.
- The development of a display food garden for backyard gardening demonstration and a water wise garden.

Open days were held to invite the community to come and view the Centre and take self-guided tours. These open days were better attended when they were held after work hours and coincided with an event happening at the Centre.

For further information please contact Rural City of Wangaratta's Sustainability Education Officer, or Council Environment Unit.



A tracking solar PV array was installed during the refurbishment at the HP Barr Reserve Community Centre in Wangaratta. The system provides electricity for the facility and education information on electricity generation.

Yackandandah Museum

The Yackandandah & District Historical Society owns and operates the Yackandandah Museum as a facility that tells the story of Yackandandah and educates our community and visitors.

A fire in December 2006 gutted the museum building. As a part of the rebuilding exercise, the committee decided that it had a responsibility to its members and the community to operate in a more sustainable manner. In doing so it felt that the Society could teach the community about environmentally sustainable alternatives and set a good example for businesses and residences alike.

In order to demonstrate and implement its environmentally sustainable principles, the Historical Society incorporated a number of energy-efficiency measures into the building.

- Insulation was installed in the external walls, ceiling and under the wooden floorboards (Foilboard).
- Installation of "Low E" (low emissivity) glass reducing the transfer of heat or cold.
- Efficient heating and cooling was installed, coupled with ceiling fans in all rooms with summer and winter modes. As the building has high ceilings, ceiling fans were required to improve air circulation.

A 1.55kW photovoltaic solar system was installed on the northern roof of the main museum building. This system provides a substantial proportion of the Museum's power requirements.

At the time of the photovoltaic installation, rebates were limited so the Historical Society applied for grants from the Federal Government, Victorian State Government and the Yackandandah Community Development Company, and were granted funds from the Victorian State Government (Sustainability Victoria) and the Yackandandah Community Development Company.

Today the Yackandandah Museum has a permanent solar education display which shows statistics such as total power generation since its installation and current power generation. They also offer a statistics sheet for visitors to take away if they are considering a solar installation of their own.

In addition, the Yackandandah & District Historical Society provides solar data in each edition of the local *Yackity Yak* community newsletter, and has been demonstrated as a Case Study in the Solar North East community solar PV bulk purchase scheme.

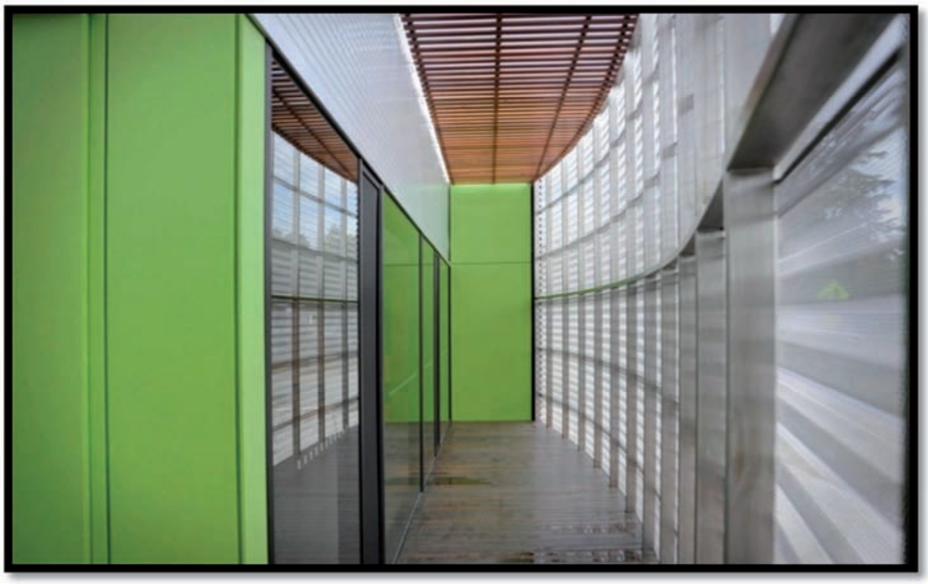
For further information please contact the Yackandandah Museum on 02 6028 0627 or email museum@yackandandah.com.

Yackandandah Museum was rebuilt after a fire damaged the property in December 2006. The committee that operates the building viewed the rebuild as an opportunity to strengthen the energy efficiency and sustainability credentials of the historical building.

Rural City of Wangaratta Performing Arts Centre

In September 2009 the Wangaratta Performing Arts Centre (PAC) was officially opened. Strict guidelines to incorporate sustainability features throughout the building were included as compulsory aspects of the project brief through the tendering process. Due to constraints of the existing site, opportunities to maximise solar orientation were limited.

The building was designed to take advantage of natural ventilation and natural light with the installation of louvre windows and ozone glazed glass. Staff were educated on how to use the design elements to maximise their impact. When louvres are opened the heating and cooling system is automatically turned off to reduce power consumption. Decorative perforated screens (see picture below) were installed externally to help reflect solar heat while still allowing natural light and ventilation into the building.



Decorative perforated metal screens were fitted to the exterior of the Performing Arts Centre in Wangaratta. The screens allow high levels of natural light and ventilation into the adjacent meeting room while reflecting solar heat.

The mechanical heating and cooling system is zoned into three main areas. Each of these zones is individually controlled and operated within the PAC and can be monitored externally by Council's Building Coordinator. The heating and cooling is also connected to an electronic control system for other electronic functioning (CBUS). This system uses infra-red motion sensors to monitor activity throughout the facility. When rooms are left vacant the lighting and heating/cooling system for these areas are turned off reducing energy consumption. Smaller rooms that are not commonly used have individual energy-efficient split systems installed for localised heating and cooling. The CBUS system is also linked to the security system. When the facility is locked after hours the control system will deactivate the heating and cooling system and any lights that may have been left on. In addition the heating and cooling system has an economy setting and carbon sensors to manage air reuse and intake.

Planned future development includes the installation of underground storage tanks for stormwater collection and reuse. Most of the infrastructure has already been put in place so that when the tanks are installed, stormwater will service the toilets, urinals and cleaner's wash basin.

All lights are either T5 or T8 fluorescent with the maintenance contract stipulating that any light bulbs that are to be replaced must be recycled. In addition, with improvements to lighting technology since the facility's opening, all light globes are being upgraded as they expire.

Waste stations throughout the Centre have separate bins for general and recyclable material. While larger scale collection of organic waste is being investigated, small organic bins have been placed in kitchenettes. The organic material collected is delivered to Council's worm farm for reuse on parks and gardens.

All landscaping gardens around the precinct focus on low maintenance, drought-tolerant native plants.

Material selection for the project included reclaimed timber flooring from the Memorial Hall, polished cement flooring with locally sourced stone features in the foyer for low maintenance, 100% wool carpets, and the northwest side of the development uses stainless steel to reduce heat gain in the theatre area.

Yackandandah Primary School Redevelopment Project

In 2009 Yackandandah Primary school began the process of designing and constructing new learning spaces. After the completion of the consultation process (which included three well-attended public meetings), the school had established four priorities for designing the new school site:

1. Maintain and enhance the old building, establishing the heritage-significant building as a feature of the school.
2. Look after the elm trees within the school grounds.
3. Construct an environmentally sound building with sustainable long-term principles and practices.
4. Build a school for the future – a contemporary school catering for 21st century teaching and learning needs.

The new site included a number of environmentally friendly design principles. These include:

Yackandandah Primary School redevelopment. The new school was officially opened in April 2011.

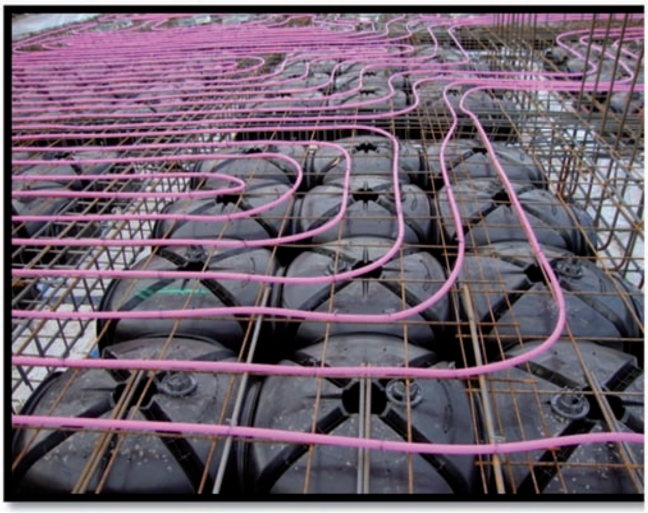
- *Solar orientation*. Building was designed for controlled solar penetration giving warmth in winter and natural daylight with appropriate shading fitted to restrict harsh summer sun.
- *Sub floor water storage (142,000 litres).* Six water tanks are located under the new building allowing water harvesting to provide thermal mass for the ventilation system. Water collected is also used to supply toilets and for garden irrigation.

- *Heating and cooling.* Hydronic radiant heating and cooling is used. A passive hydrothermal air-conditioning system is part of the buildings integrated environmental response for maintaining comfort and reducing energy consumption. The heating is a zoned, low level hydronic system operating on heat pump units. The system responds efficiently to spatial volumes and orientation.
- *Thermal mass.* Cooled or heated air is passed through PVC pipes embedded below the concrete floor slab. This supports heating and cooling requirements.
- *Limit temperature fluctuations.* A number of techniques are used to maintain comfort and reduce fluctuations of indoor temperature. These include using: cross ventilation, night purging through a passive ventilation system, thermal mass in the concrete floor slabs and internal walls, sub-floor water storage and quality insulation.
- *Heritage significant elm trees.* The heritage significant trees continue to shade the school grounds and new building.
- *Lighting.* LED, T5 and compact fluorescent fittings with movement sensor control systems were fitted.
- *Window type and position.* The soaring windows are designed to control solar penetration and cross ventilation. These windows are positioned to allow for natural lighting, even cross ventilation and night purging. Low E glass was used to reduce thermal transfer, glare and the deterioration of internal surfaces.
- *Consideration of life cycling and embodied energy in selection of construction materials.*

The new building has already attracted national and international recognition for its environmental design principles. The project was a finalist in the “Green Building Awards” and took out first place at the Australasian Region “Renovation/Modernisation of a School/Major Facility” CEFPI awards. The school also won the “Education” category of the Indigo Shire Sustainability Awards for 2011.

The school community is continuing to work towards installing solar panels onto existing frames at the site. When fitted with the panels the canopy will also offer shade. Information on solar energy generation will be displayed.

In addition, the school has constructed a wood-fired pizza oven, which is used on a regular basis by community groups and the school. The school plans to develop a kitchen garden to further develop the concept of growing, harvesting and cooking.



Warm or cooled air is pumped through pipes in the high thermal mass flooring to deliver heating and cooling for the school.

For further information please contact Kathryn McAuliffe, Principal, Yackandandah Primary School or email mcauliffe.kathryn.a@edumail.vic.gov.au.

1860 Luxury Accommodation

1860 Luxury Accommodation in Beechworth provides self-contained accommodation for couples. The building itself is a fully restored, 150 year old, hand hewn mountain hut which was salvaged from a farm in Taggerty, Victoria. The reconstruction of the hut occurred over four years from 2004 to 2007.

The building is a sympathetic heritage rescue where virtually all construction materials have been salvaged, recycled or converted from another use. Where possible, materials have been sourced locally. As a result the building has very low embodied energy and the owners were able to recover many materials that would usually end up as waste, or have been left to deteriorate. By avoiding the need to purchase new items, energy and raw materials have been conserved.

The origins of some of the construction and fit out items are as follows:

- Slab hut, two main rooms – Farm, Taggerty.
- Slabs around ensuite and kitchen – Old stables, Markwood.
- Truss timbers and kitchen benches – Old warehouse, Albury.
- Jarrah floorboards - Old army training barracks, Wangaratta.
- Baltic pine ceilings - Old house, Tungamah.
- Blacksmith bellows coffee table - Farm near Yackandandah.
- Blue gum dining table – Benches, Army barracks.
- Red gum posts – Milled from rescued trees, King Valley.
- Corrugated iron roof - Old stables, Markwood.
- Fence paling – Salvaged red gum, Baddaginnie.

The accommodation also employs ongoing environmentally sustainable initiatives. These include 100% grid Greenpower (wind and solar), compost and waste recycling programs, environmentally sensitive cleaning and washing products, on demand hot water only heated when guests are staying, electronic booking and communication with guests to reduce paper use, and locally sourced food products for breakfast baskets.

The owners approach to business has been to minimise the ecological cost to the environment. They hope the building and the experience will inspire guests and other accommodation providers to consider the benefits of recycling, reusing and reclaiming materials for building construction. If handled sensitively, old buildings can be restored into successful businesses that offer ambience and charm that is difficult to replicate with new materials and techniques. Furthermore, heritage preservation flies in the face of a “throw-away” society. The sustainability features of both the hut itself and business operation saw the accommodation win the “Business” category of the Indigo Shire Sustainability Awards in 2011.

For further information contact Gina Bladon at www.1860luxuryaccommodation.com

1860 Luxury accommodation is an award winning business that has embedded sustainability principles into both the building of the lodging and its administration. Virtually all building materials have been salvaged, recycled or converted from another use.

PART B – Checklist & Summary

Checklist

The following checklist is a basic tool to prompt discussion when planning and designing your site. Each item may contribute towards improving the energy efficiency and sustainability performance of the building. Depending on the scope and intent of the building not all items may be relevant. Tick elements that you have been able to include during the design phase. Consider areas that have not been selected as opportunities for additional improvement.

	Pre Design - Resource Efficiency & Life Cycle Thinking	**Yes / No**
1	Use existing infrastructure and building and explore adaptation, remodelling and energy efficiency improvements.	
2	Build using the least area required to meet needs.	
3	Analysis life-cycle cost of materials, equipment, energy use, maintenance and disposal.	
	Siting, Passive Solar Design and Landscaping	**Yes / No**
1	Plan a predesign workshop to establish environmental targets and opportunities. *Engage consultant if required to explore energy audit options and solutions.*	
2	Use passive design principles to minimise heat gain and loss to maximise comfort levels and reduce energy requirements for heating and cooling.	
3	Design to optimise natural ventilation and lighting (while prioritising minimisation of heat gain/loss).	
4	Maximise insulation for climate zone rather than using minimum building requirements. *Strengthen passive design features with high quality insulation.*	
5	Use light coloured surfaces to reduce heat load on the building.	
6	Install double glazing to reduce heat loss and allow good levels of natural light.	
7	Fit window protection and treatments, both externally and internally where appropriate.	
8	Design the roof for energy creation, water runoff abatement, or consider a green roof project.	
	Energy Management	**Yes / No**
1	Model, consult and educate users for a temperature range between 19-24 degrees.	
2	Include zoning to reduce lighting, heating and cooling requirements.	
3	Install high efficiency technology to meet any additional heating or cooling needs.	
4	Purchase 4 star or greater white goods and general appliances and investigate the energy efficiency credentials of copiers, printers and IT equipment.	
5	Install energy efficient hot water appropriate for your operation.	
6	Install renewable energy. *Solar panels, wind power, solar thermal, biomass or cogeneration.*	
7	Fit automatically closing doors and air locks to reduce heating and cooling loss.	
8	Fit non-essential equipment to standby eliminators or power down when not in use.	
9	Fit programmable thermostats and timers to turn off appliances outside of normal operating hours.	
10	Consider purchasing green energy to meet any additional energy requirements for the building.	

Energy Management		**Yes / No**
11	Maximise natural lighting wherever possible.	
12	Install energy-efficient lighting solutions such as LED to meet additional lighting needs.	
13	Install sensor lighting, timers, dimmer switches where appropriate.	
14	Avoid installing halogen down lights.	

Waste		**Yes / No**
1	Recover, reuse and recycle as much material as possible from all demolition and construction stages.	
2	Implement waste separation and recycling stations at appropriate high use locations, across the building. For example, kitchens, restrooms, print stations.	
3	Design a location for composting or worm farming of organic waste.	
4	Fit a filter to kitchen water supply to negate the supply of bottled water for staff use.	

Material Selection, Fit Outs and Indoor Air Quality		**Yes / No**
1	Install natural fibre or eco-carpets to reduce off-gassing and indoor air pollution.	
2	Select low VOC materials for partitions, sealants, coatings, insulation, and paints. *For example, use water-based paints and adhesives.*	
3	Consider insulation products with high recycled content.	
4	Source office furniture or general fit-out materials from green suppliers. *You can buy reused, reconditioned, or reproduced office furniture with high levels of recycled content. Check resources such as Eco Buy for further information*	
5	Assess if natural construction materials (less damaging to the environment) are suitable for your project. *Includes rock, straw bales, bamboo, rammed earth, or adobe.*	
6	Use indoor plants to improve indoor air quality.	
7	Ensure a safe location for any hazardous chemicals that must be stored on-site.	

Water Management		**Yes / No**
1	Install water-efficient toilets, taps, shower fittings and appliances.	
2	Install self-closing taps and tap aerators.	
3	Connect water tanks for toilet flushing, irrigation and landscaping maintenance.	
4	Install oversized downpipes to accommodate storm surges and rain water capture.	
5	Evaluate the decision to install hand dryers or paper hand towel in rest rooms. *Paper hand towel is resource intensive and can create considerable waste. Encourage recycling of uncontaminated paper hand towels or install energy-efficient hand dryers.*	
6	Use permeable paving for hard outdoor surfaces to filter and reduce run-off.	
7	Use design features and landscaping to reduce the impact of stormwater.	
8	Investigate options for Water Sensitive Urban Design (WSUD) for the site.	
9	Plant drought tolerant indigenous species when landscaping.	

Swimming Pools		**Yes / No**
1	Position pools to minimise evaporation and maximise solar access for heating.	
2	Use a pool cover to reduce water evaporation and maintenance, while retaining heat.	
3	Equip pool with energy-efficient pump, filtration and cleaning systems.	

Transport		**Yes / No**
1	Install secure, undercover bicycle storage.	
2	Provide shower, locker and change facilities to encourage physical activities and cycling.	
3	Ensure safe pedestrian access.	
4	Give “car pooling” vehicles higher priority parking.	
5	Consider green fleet options for your vehicles and machinery. *Including hybrid cars, electric or dual fuel vehicles and motorcycles.*	

Biodiversity		**Yes / No**
1	Check planning and biodiversity GIS layers and other resources to assess if the area is ecologically sensitive.	
2	Where possible protect remnant indigenous vegetation on-site.	

Promotion		**Yes / No**
1	Consider using project as an educational or demonstration project.	
2	Document capital costs, operating savings, and reductions in environmental impacts to monitor outcomes and identify opportunities for improvement.	
3	Apply for environmental awards.	

Summary of Opportunities

The following provides a starting point for action on building efficiency.

Action	Cost	Benefit
Integrate passive design features in existing design *Rework existing floor plan to support solar passive design*	Varied	Relocating work areas and improving the use of existing space can enhance occupant comfort and reduce heating and cooling requirements
Upgrade or install quality insulation *Roof, ceiling, wall and floors as well as lagging hot water pipes to reduce heat loss*	Low to medium	Reduce operating costs and improve comfort levels by restricting heat gain and loss
Identify and seal draughts	Low	Reduce winter heat loss and summer heat gain.
Upgrade windows *Install secondary glazing product or replace windows with higher efficiency systems*	Medium to high	Reduce running costs and improve comfort levels by restricting heat gain or loss
Install window protection *Internal and external forms of shading, awning, curtains, pelmets etc*	Medium	Improve comfort and reduce running cost by reducing heat gain or loss
Install water tanks	Medium	Reduce reliance on potable water, reduce storm water run-off and create a water supply for select workplace activities and irrigation
Retrofit water saving devices *Tap aerators, low flow shower heads, dual flush toilets, stop taps*	Low	Reduce water consumption
Install a renewable energy source *Solar PV, wind, biomass, cogeneration*	High	Reduce reliance on non-renewable electricity
Upgrade to energy-efficient lighting *Assess lighting needs for purpose and install energy efficient technology*	Low	Task-relevant energy-efficient lighting can improve the indoor work environment, increase productivity and reduce energy consumption
Purchase energy and water-efficient appliances *When buying new or replacing obsolete models*	Varied	Reduce operational costs and resource consumption
Install an energy-efficient, size appropriate, hot water system	High	Reduce operating costs and energy consumption
Consider passive or energy-efficient heating and cooling solutions *Apply building materials and design to provide for passive/energy efficient heating and cooling options*	Varied	Reduce operating costs and energy consumption
Landscape outdoor areas to support passive design *Choose drought tolerant native species. Plant to maximise summer shading and provide solar access in winter*	Low	Decrease water and fertiliser requirements and increase probability of plant establishment. Reduce heating and cooling costs.

Links & Resources

Alternative Technology Association (ATA)

The ATA is Australia's leading not-for-profit organisation promoting sustainable technology and practices. They also advocate and conduct research into sustainable living.
http://www.ata.org.au

Australian Green Procurement

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

NABERS

NABERS OFFICE/WATER is a Australian Government tool that can be used to assess the operational impacts of an existing buildings environmental performance and water consumption.
http://www.nabers.com.au/
http://www.resourcesmart.vic.gov.au/for_businesses/commercial_2382.html

Commercial Building Disclosure - Mandatory energy efficiency disclosure for large commercial office buildings.
http://cbd.gov.au/

Clearwater

Clearwater is a capacity building program funded by Melbourne Water with contribution from DSE, EPA and MAV, to inform water sensitive urban design. Clearwater provides technical training, tours, events, advice, and online information to support those planning and designing urban environments.
http://www.clearwater.asn.au/

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 for selection of materials on an environmentally preferred basis. The website helps evaluate material life cycles and the sourcing of greener products.
http://www.ecospecifier.org

Energy Efficiency Council

The Energy Efficiency Council is a peak body formed in 2009 for energy efficiency and cogeneration products and services for the non-residential sector. The site provides updates on the industry along with best-practice guides and case studies.
http://www.eec.org.au/

Good Environmental Choice Australia (GECA)

Good Environmental Choice Australia (GECA) is a not-for-profit independent organisation and Australia's leading certifier of environmentally-preferable goods and services.
www.geca.org.au

GreenStar

Developed by the Green Building Council of Australia (GBCA), the tool relates to the various cycles of development, including design, purchasing, construction, and refurbishment.
http://www.gbca.org.au/

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

Melbourne Forums

These organisations have formed a partnership to deliver a series of free public talks with the goal of increasing the development and refurbishment of commercial buildings in Victoria to achieve greater levels of sustainable performance.

To find out more information or down load previous presentations go to:
http://www.airah.org.au/iMIS15_Prod/AIRAH/Events2/Melbourne_Forum/AIRAH/Navigation/Events2/MelbourneForum/Melbourne_Forum.aspx?hkey=d7f9ccdc-a7b2-4561-888d-fb5a80d4b3fb

ResourceSmart (Sustainability Victoria)

The ResourceSmart website was designed to present the programs, services and information created by Sustainability Victoria. Below are information sheets on passive design, energy-efficient options and waste management.

Solar Chimney
http://www.resourcesmart.vic.gov.au/documents/solar_chimney.pdf

Natural ventilation systems
http://www.resourcesmart.vic.gov.au/documents/Natural_Ventilation_Systems.pdf

Transpired Solar Air Heaters
http://www.resourcesmart.vic.gov.au/documents/Transpired_Solar_Air_Heaters(1).pdf

Daylighting light shelves
http://www.resourcesmart.vic.gov.au/documents/light_shelves.pdf

Daylighting light pipes
http://www.resourcesmart.vic.gov.au/documents/light_pipes.pdf

Dual Purpose solar hot water systems
http://www.resourcesmart.vic.gov.au/documents/dual_purposeSHW.pdf

Power generation - PV with heat recovery
http://www.resourcesmart.vic.gov.au/documents/photovoltaic_systems.pdf

Recycling and Reusing in your work place – A guide to recycling and reusing office waste
http://www.resourcesmart.vic.gov.au/documents/Recycling_and_reusing_in_your_workplace.pdf

Thermal Mass
http://www.resourcesmart.vic.gov.au/documents/Thermal_Mass(1).pdf

Thermal Storage –Thombe walls
http://www.resourcesmart.vic.gov.au/documents/trombe_walls.pdf

Thermal Storage – Hollow core
http://www.resourcesmart.vic.gov.au/documents/hollow_core.pdf

Schools
http://www.resourcesmart.vic.gov.au/for_educators/energy_2516.html

SDS Scorecard

Established in 1999, the Sustainable Design Scorecard (SDS) is intended to assess and quantify the environmental performance of ***non-residential*** developments in Victoria. SDS Version 7 is an improvement on earlier versions of the Scorecard. It has updated the tool's capacity to allow for a greater number of options to achieve the targets in each environmental category. This version of the Scorecard supersedes all previous electronic and paper-based variations.
http://www.sustainablesteps.com.au/

The Green Directory

Online resource for locating green businesses, services and products.
http://www.thegreendirectory.com.au

Utility Tracker

Monitor utility accounts with utility tracker, a free MS Access application aimed at Local Government use. It may also be suitable for a broad range of organisations.
http://www.resourcesmart.vic.gov.au/for_government/energy_2310.html

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/index.html

Window Energy Rating Scheme (WERS)
Independently managed by the Australian Windows Association, WERS rates the energy impact of a window across any climate in Australia.
http://www.waterrating.gov.au/index.html

Your Building – Prospering from Sustainability
This site provides information on improving the environmental performance of a commercial property. It connects investors, designers, managers and occupants with material, articles and case studies.
http://www.yourbuilding.org/

References

Ambius*, The Benefits of Indoor Plants*. (25/7/2012)
http://www.ambiusindoorplants.com.au/office-plants/benefits/index.html

Ausgrid, *Swimming pool efficiency, Pool/Spa*. 2011. (25/7/2012)
http://www.ausgrid.com.au/Common/Ways-to-save/Energy-efficiency-at-home/~/media/Files/CommonRetail/Energy%20save/Ausgrid_Swimming_Pool_Spa_2011.pdf

Building Management Systems. (05/06/2012)
http://en.wikipedia.org/wiki/Building_management_system

City of Darebin, *Darebin ESD Requirements – Sustainable Design for Council Buildings.* (1/11/2011)
http://mams.rmit.edu.au/160bybxdjrcc.pdf

City of Melbourne – *1200 Building, Project Advice Sheet – Using rating tools in a retrofit. (12/7/2012)*
http://www.melbourne.vic.gov.au/1200buildings/resources/documents/advice_sheet_2_rating_tools.pdf

Clean Energy Council, *Cogeneration & Trigeneration*. 2012. (25/07/2012)
http://www.cleanenergycouncil.org.au/technologies/cogeneration.html

Department of Climate Change and Energy Efficiency, *Building Management Systems, Summary*. (5/06/2012)
http://www.climatechange.gov.au/government/initiatives/eego/~/media/publications/eego/BMS-guide-pdg.pdf

Department of Climate Change and Energy Efficiency, Your Home Technical manual – *Rating Tools.* (10/7/2012)
http://www.yourhome.gov.au/technical/pubs/fs15.pdf

Department of Environment and Water Resources, *ESD Design Guide.* (1/10/2011)
http://www.environment.gov.au/sustainability/government/publications/esd-design/pubs/esd-design-guide.pdf

Department of Environment, Water, Heritage and the Arts, *ESD Design Guide for Office and Public Buildings*, Dominque Hes. (28/5/2012)
http://unimelb.academia.edu/DominiqueHes/Papers/393974/ESD_Design_Guide_for_Office_and_Public_Buildings

Earth Check Pty Ltd, *Earth Check Fact Sheet;4, Efficient Water Heating*. (29/05/2012)
http://www.earthcheck.org/media/7936/FS04%20-%20Efficient%20Water%20Heating.pdf

EcoSpecificer, *Purification of Indoor Air Quality – Negative Ion and Plant*. (25/107/2012)
http://www.ecospecifier.com.au/knowledge-green/technical-guides/technical-guide-2-purification-of-indoor-air-quality-%E2%80%93-negative-ions-plants.aspx

Green Building Council of Australia, *Green Star - Public Building Pilot.* (01/11/2012)
http://www.gbca.org.au/green-star/rating-tools/green-star-public-building-pilot/3267.htm

Green Renovation, *Water Ionisers – Floatron*. (25/7/2012)
http://www.greenrenovation.com.au/swimminng-pools/water-ionisers/

NABERS - Home
http://www.nabers.com.au/

Newcastle City Council, *Newcastle Small Business Sustainability Initiative, Efficient Commercial Kitchen Fact Sheet.* (23/4/2012)
http://www.newcastle.nsw.gov.au/__data/assets/pdf_file/0007/94858/Efficient_Commercial_Kitchen_FactSheet.pdf

Penrith City Council, *Sustainable Development Checklist for Penrith City Centre and St Mary Centre.* (01/10/2011)
http://www.penrithcity.nsw.gov.au/uploadedFiles/Website/Planning_&_Development/Our_City_Centres/SustainableDevelopmentChecklist.pdf

Resource Smart - *Commercial Building Program*
http://www.resourcesmart.vic.gov.au/for_businesses.html (31/1/2012)
http://www.resourcesmart.vic.gov.au/for_businesses/energy.html (31/1/2012)

Resource Smart, *legislation and rating tools, NABERS.* (12/07/2012)
http://www.resourcesmart.vic.gov.au/for_businesses/legislation_rating_tools_2382.html

Shellharbour City Council, *Environmentally Sustainable Building Design for Council Buildings*. (1/10/2011)
http://www.shellharbour.nsw.gov.au/default.aspx?WebPage=332#Intro

Shellharbour City Council, *Environmentally Sustainable Building Design for Council Buildings Background Paper.* (1/10/2011)
http://www.shellharbour.nsw.gov.au/FileData/pdf/ESBDBackgroundPaper.pdf

SKM Consulting, *Incentives for Sustainable Buildings in Australia – A Designer's Perspective.* (05/05/2012)
http://www.skmconsulting.com/Site-Documents/Technical-Papers/Incentives%20for%20Sustainable%20Buildings%20in%20Australia.pdf

Sustainable Buildings Victoria. (31/10/ 2011)
http://www.sustainablebuildingsvic.com.au/#/projects

Sustainability Victoria, *Save Yourself Tips*. (5/5/2012)
http://www.sustainability.vic.gov.au/resources/documents/save-yourself-tips.doc

Sustainability Victoria, *Solar Technologies Report*. (1/10/2011)
www.sustainability.vic.gov.au/resources/documents/Solar_Technologies_Report.xls

Total Environment Centre, *Roadmap of a sustainable building – Tools to progress sustainability for SMEs*, May 2009. (31/10/2011)
http://thehub.ethics.org.au/uploads/files/TEC_Sustainable_Building_Tools(1).pdf

Rear Cover Photos: Rear Main: Performing Arts Centre, Wangaratta. *Breeze way & decorative perforated screens.* Top Insert: Performing Arts Centre, Wangaratta, *recycling station*. Middle Insert: Havelock Rd Stormwater Management System Beechworth, *bio filter*. Bottom Insert: Charles Sturt University, Albury-Wodonga Campus, *bicycle storage and lockers.*

INDIGO
SHIRE
COUNCIL

November 2012

100% Recycled Paper