Energy Efficiency
Building design for a sustainable future

This fact sheet explains how energy efficient design and specification principles can be incorporated into your next building project and the benefits that can be shared not only by you, but all Victorians.

Why do our buildings need to change?
Around 40% of the world’s energy resources are used in our buildings – both residential and commercial. Estimates show that the use of electricity contributes approximately 70% of Victoria’s total greenhouse gas emissions due to our reliance on brown coal. Passive design principles including thermal mass, external shading, building orientation, cross ventilation and better insulation in buildings lead to less reliance on energy hungry mechanical systems to maintain comfortable internal temperatures. Using renewable energy further reduces a building’s environmental impact. Good building design decreases power consumption, saves money and reduces the effects of climate change. On the other hand, poor building design is uneconomical and contributes to greenhouse gas emissions.

Why do our buildings need to change?

How will improved Energy Efficiency benefit me?

As an owner/occupier you can expect:
• lower energy bills due to less reliance on active heating and cooling systems
• improved living comfort
• future proofing of your building asset.

Developers and builders can take advantage of:
• enhanced market appeal to prospective purchasers
• higher investment returns
• a development that meets best practice standards and more importantly, community expectations.

How will improved Energy Efficiency benefit me?

Whether you are an owner, occupier, builder or property developer, adopting Environmentally Sustainable Design (ESD) principles in the design and construction of buildings and renovations can result in marked benefits, both now and in the future.
What can I do to enhance Energy Efficiency?

For both home owners planning a renovation to an existing dwelling and developers planning to construct multi-storey buildings, it is important to ensure that ESD is considered during the initial scoping stages of a project. In fact, it is more costly to incorporate sustainability measures after the design process is complete. The following information in this fact sheet will help you to identify and address the key areas of energy efficient building design.

Building envelope

The exterior of a building is often referred to as the ‘building envelope’. The building envelope ensures that occupants are protected from the elements such as heat, cold, wind and rain. To maximise the building envelope’s thermal protective capabilities:

- Insulate walls, floors and ceilings, exceeding current standards.
- Draft-proof any gaps around doors, windows and vents including any opening between the interior and exterior of the building.
- Consider the use of exposed ‘thermal mass’ of a building to balance a building’s internal temperatures through heat storage and release.
- Specify high performance windows.

Reducing your energy demand through an energy efficient building envelope

Thermal mass (e.g. exposed concrete floor) can store and release heat in winter when exposed to direct sun. In summer, thermal mass can assist with passive cooling by releasing the stored heat at night through effective means of ventilation (night purging).

Internal layout and orientation

To minimise your reliance on mechanical heating and cooling systems, consider the following design principles:

- Orient living areas to a northerly aspect or as close to as possible, to take advantage of passive solar gains during colder months.
- The positioning and size of windows impacts on the amount of artificial lighting required during daylight hours. To maximize light ingress, it is preferable to use clear glazing. You can use highlight or roof windows to increase lighting levels in buildings with deep floor plans.
- Carefully study the location of your project. Is there the chance of overshadowing from neighbouring buildings? If so, consider how you might overcome any potential problems through clever window placement or reorienting your building.
- Try to cluster heated rooms together. Separate rooms with doors and apply internal insulation to walls adjacent to non-heated rooms. For example, adjoining garages and storage areas can be just as cold as the temperature outside.

Building compliance for residential and commercial buildings

How can you be certain that your building envelope meets best practice energy efficiency standards? Before commencing a major renovation or new construction, a building permit will be required, confirming compliance with the National Construction Code of Australia (NCC).

Residential buildings receive an energy efficiency rating which is calculated through tools such as:

- FirstRate
- Building Energy Rating Scheme (BERS) Pro
- Accurate

The rating reflects a dwelling’s energy efficiency and is measured on a scale of 1 to 10 Stars. A 1 Star rating means that the dwelling is extremely inefficient and ‘energy hungry’. While a 10 Star rated building is extremely energy efficient and requires very little or no energy for heating and cooling due to the passive design principles incorporated during the building’s early design stages. Similarly, non-residential buildings must also meet the NCCs energy efficiency standards. However, this is determined using different modelling tools that rate the relative energy efficiencies of a building.

It’s important to be aware that the NCC only describes minimum standards that must be met and not what is considered best practice. To ensure you future proof your asset, it is strongly recommended that you exceed today’s minimum standards.

Energy efficient office buildings are generally rated above 4 Stars under the National Australian Built Environment Rating System (NABERS). This also makes sure your property will remain a ‘good performer’ as the standards will be raised over time and that you are ready for the recently introduced mandatory disclosure scheme.
What can I do to enhance Energy Efficiency?

### Heating and cooling systems

Choosing the correct heating and/or cooling system for your project can have a big impact on your energy consumption and greenhouse gas emissions.

Smart buildings and renovations will incorporate passive solar design in their construction. This may include above standard insulation, external shading that can be adjusted to changing climate conditions, good cross ventilation and the best possible building orientation.

When all of these are combined, buildings will have significantly lower heating requirements in winter and you may be able to avoid the need for active cooling systems in summer.

When choosing an active heating and cooling system (reliant on energy to power), be aware that each has its pros and its cons. Some general rules apply:

- Gas fuelled systems create considerably less carbon emissions than electricity fuelled systems.
- The efficiency of a heating and cooling system is rated in stars. The higher the star rating, the more efficient the unit.
- Hydronic heating systems (run by hot water) can utilise the sun’s renewable energy in the form of a ‘solar-boosted’ heating system, that works just like the solar hot water system on your roof.
- Central systems in larger commercial developments are generally more energy efficient. However, individual systems are more flexible and can be easily modified to suit a building’s changing occupancy.
- Some systems are inherently more efficient than others. A ceiling fan, for example, will always consume less energy than an efficient air-conditioner.

### Lighting

When considering artificial lighting design, weigh up these design options:

- Ensure living areas, including kitchen and bedrooms, do not require any artificial lighting throughout the day.
- Familiarise yourself with appropriate lighting requirements (how bright is bright enough?) for different living and working spaces.
- Choose energy efficient lights and lamps.
- Install efficient lighting controls such as motion, sound and daylight sensors and time switches, or a ‘master switch’ that controls several lights, and possibly appliances, at once.

### Renewable energy generation

In addition to good “green” design and performance, many buildings are now being designed to generate their own energy to supplement or meet everyday’s energy consumption. Council supports these initiatives and recommends exploring onsite renewable energy production. Renewable energy options include photovoltaic solar panels and small wind turbines for electricity production, solar hot-water heating systems, and geothermal systems for space heating and cooling.

Solar hot water systems are the most common systems that work with renewable energy - free energy from the sun.

While we weren’t able to provide renewable energy for all 150 apartments, we at least covered all common area electricity demand (lighting and ventilation for entrance lobby, corridors and basement) through onsite electricity generation with photovoltaic panels. That way we not only reduce the development’s environmental footprint, but also reduce the body’s corporate fees.
Water heaters
On average, hot water heating contributes 20 per cent of a household’s energy bill. Choosing a highly efficient system reduces energy costs and a building’s environmental footprint. Water heaters follow similar guidelines to heating and cooling devices:
- Gas fuelled systems are commonly more efficient than electricity fuelled systems.
- The efficiency of a hot water system is rated in stars. The more the better.
- A solar hot water system provides a large proportion of the energy required to heat water by directly using the sun’s energy. Where possible, supplement outstanding energy requirements using a gas booster, known as a gas boosted solar hot water system.
- Instantaneous systems are generally more efficient than storage systems as there is no water being stored and constantly reheated. However, this can vary, depending on the fuel source, be it renewable energy, electricity or gas.

Reducing peak demand
Peak energy demand refers to the use of electricity, caused by extreme weather events such as heat waves and cold snaps. For example, on a hot summers day, the Victorian electricity grid carries an additional load of up to 20% due to the additional use of air conditioners. Extreme conditions occur on a relatively few number of days per year however this peak demand is enough to increase demand for the construction of new power stations.

The impact on consumers is additional costs for the entire year as Victoria’s energy grid is 20% larger than it would need to be without peak demand. However, we can all take steps to help reduce peak demand on our electricity supplies by:
- installing efficient shading
- providing good insulation
- only using high efficiency heating and cooling systems, which means that specified systems should be within 1 Star of the highest rating available
- installing photovoltaic panels that produce energy when it is needed most - on a hot summers day.

Clothes drying facility
A well designed residential dwelling should incorporate natural clothes drying facilities. External drying spaces give the occupant the opportunity to use sun and wind to dry clothes rather than electrical appliances. Apartment buildings could provide retractable drying racks on individual balconies or a common clothes line on the building’s roof terrace.

Where can I find out more?
- 6 Star Energy Efficiency Requirements
  Victorian Building Authority
  www.vba.vic.gov.au
- Find an accredited Thermal Performance Assessor
  Association of Building Sustainability Assessors
  www.absa.net.au
  Building Designers Association Victoria
  www.bdav.org.au
- National Australian Built Environment Rating System (NABERS)
  www.nabers.gov.au
- Choose an Energy Efficient Appliance
  Department of Climate Change and Energy Efficiency
  www.energyrating.gov.au
  Sustainability Victoria
- Energy Use Technical Manual
  Your Home
  www.yourhome.gov.au
- Other Fact Sheets in this series are also available to provide guidance on the 10 Key Sustainable Building Categories. For further information on Energy Efficiency, see the Fact Sheets entitled:
  - Indoor Environment Quality
  - Urban Ecology
  - Building Materials.
  - Sun Shading
  - Melbourne’s Climate
Sunshading
Building design for a sustainable future

What’s included in this fact sheet:

What is sunshading?
Sun angles
Comparing different external shading devices
• Integrated or ‘built in’ devices
• Fixed horizontal projection
• Fixed horizontal battens
• Adjustable horizontal projection(s)
• Fixed vertical fins
• Adjustable vertical fins or battens
• Fixed perforated screens

Where can I find out more?
Mandatory Requirements
Best Practice Standards
Show on Planning Application Drawings

This Fact Sheet explains the different types of sun shading and the impact it will have on the indoor environment quality and energy demand of a building. It also details the type of shading that is best suited to the different orientations and facades of the building.

What is sunshading?

Historical architecture relied on passive design approaches, such as the inclusion of sun shading to provide comfortable indoor conditions. Since the second half of the 20th century, when technology became affordable and readily available, building design was able to rely on energy hungry devices, such as air conditioning and artificial lighting to provide the desired comfort. With energy becoming more expensive and showing the effects on our environment, Council encourages you to design buildings that thrive on passive design, rather than active appliances.

Did you know that external sun shading can be up to 5 times more effective than internal shading?

External shading devices protect the building envelope and reduce heat transfer through the building fabric. Whereas internal shading devices can reflect a small proportion of the heat that has already penetrated the buildings fabric.

The effectiveness of different shading devices is expressed as the Fc value, also called the shading factor. It is measured in the proportion of solar energy entering a window. A low figure means the shading device is very effective, most of the solar energy is excluded. A high figure means the shading device is not very effective, a lot of heat enters the room. A figure of 1 means no shading device is applied. Refer to the example of internal and external louvres below.
The graphic to the right shows how sun angles change, depending on the season, the orientation, and time of the day. Generally speaking, summer sun angles are high (up to 75°) and winter angles are considerably lower (up to 29°). Furthermore, midday sun in the North is higher than morning or evening sun in the East and West.

**North:**
Due to the sun’s high angle in summer, shading can be horizontal and fixed. To provide full shading from late October to late February in Melbourne, the depth of the horizontal overhang should be approximately 45% of the vertical height to be shaded, measured from the window sill to the underside of the shading device. This depth represents a good compromise between shading in summer and winter solar gain. Fixed horizontal shading can be provided through structures, such as eaves, awnings, pergolas and verandas. Adjustable external shading devices are also an option for north facing glazing, however they rely on the occupier understanding when to operate them for maximum benefit.

**East and West:**
Even in summer, eastern and western facades are exposed to relatively low sun angles. On 21 December (mid-summer), eastern and western sun angles remain below 60°. Due to those low sun angles, normal fixed horizontal sun shading becomes ineffective. Therefore adjustable shading devices are recommended. These include (horizontal or vertical) canvas blinds, conventional or roller shutters, angled metal or timber slats and shade cloth over pergolas. The flexibility will allow occupants to respond to different seasons and individual comfort levels. Furthermore, well designed flexible shading will contribute to a building’s architectural appearance and meet occupant’s privacy requirements.

**South:**
In Australia, southern facades receive very little direct sunlight. Only in mid-summer will some low angled sun hit a southern facade, in the morning and evening. Therefore it is not required to provide external shading devices. However, when a building has an overheating problem, a flexible shading installation on the southwest can be an valuable addition. Nevertheless, internal glare protection should be provided, especially for working environments.
## Sunshading Description

### No Shading device
Relying solely on the thermal performance of the window and glazing system to prevent heat transfer which is usually the building’s weakest point. Internal blinds will be minimally effective.

- **Benefits and limitations:**
  - Not effective
  - North:
    - Good during winter
    - Not good during summer
  - East/West:
    - Good during winter
    - Not good during summer

### Integrated or ‘built in’ sunshading
The sunshading is usually integrated into the design of the building such as an eave, overhang or balcony which cannot be easily removed and is considered within the overall design of the building.

- **Benefits and limitations:**
  - Moderately to very effective
  - North:
    - Ideal if designed at 45% rule
  - East/West:
    - Will have some impact but is not optimal

### Fixed horizontal projection
The sunshading is commonly fixed above the glazing to the building’s facade. If designed to the 45% rule for Melbourne it will effectively shade the glazing during summer and allow for the sun to penetrate through the building envelope in winter.

- **Benefits and limitations:**
  - Moderately to very effective
  - North:
    - Ideal if designed to 45% rule
  - East/West:
    - Will have some impact but is not sufficient

### Fixed horizontal battens
Timber, aluminium or other material battens are placed at carefully considered spacings across the glazing and fixed to the façade. This can be very effective if designed to the 45% rule for the battens and spacing.

- **Benefits and limitations:**
  - Moderately to very effective
  - Can prevent overlooking
  - Will reduce daylight penetration
  - North:
    - Ideal if designed to 45% rule
  - East/West:
    - Will have some impact but is not sufficient

### Adjustable devices
Adjustable shading devices are typically roller blinds, sliding screens or shutters which commonly are constructed in timber, aluminium or shading fabric and are either integrated into the building fabric or are fixed to the external façade. These can be manually operated or automated and allow for the occupant to easily control their thermal comfort.

- **Benefits and limitations:**
  - Very effective
  - North:
    - Good option if the user operates the shading device at the right times, i.e. closing shutters on summer days to reduce heat gains and having shutters open on winter days to capture wanted solar energy
  - East/West:
    - Ideal to control eastern and western solar gains. However, as per north orientation, it relies on occupant awareness to function as intended

### Fixed vertical fins or battens
Vertical elements cover the glazing and are fixed to the building’s facade. These elements typically provide shading for one direction. Installed on west facing glazing, they block most western sun. However, spacings and angles are important as protection will be at its least when the sun is parallel to the device’s angle.

- **Benefits and limitations:**
  - Moderately to very effective
  - Can prevent overlooking
  - North:
    - Moderately effective as it will not protect glazing at optimal times. Midday sun will strike the glass which is good in winter but undesirable in summer
  - East/West:
    - Very effective
## Sunshading Description

<table>
<thead>
<tr>
<th>Adjustable vertical fins/battens</th>
<th>Benefits and limitations</th>
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</thead>
</table>
| Adjustable vertical elements, such as sliding shutters or rotating fins which are placed across the glazing. These can be manually or automatically operated to protect the glazing at optimal times. | • Very effective  
• North, East & West: Very effective if adjusted according to the changing seasons and sun angles |

<table>
<thead>
<tr>
<th>Fixed perforated screens</th>
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| Perforated screens or meshes will provide varying levels of shading to the glazing, depending on their percentage of transparency. Patterns can be generic or custom designed to suit different applications. | • Moderately effective  
• Can prevent overlooking  
• Will reduce daylight penetration  
• North, East & West: Moderately effective as commonly too little heat gain is prevented in summer and too little heat gain is possible in winter |

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**It is amazing what a difference the installation of external blinds made. In summer we just keep them closed during the day, which means when coming home in the evening the house is still comfortably cool. In the past we had to turn on the air conditioning units and wait at least half an hour before temperatures became comfortable. Not to mention the electricity costs associated with relying on air-conditioning.**

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## Where can I find out more?

**How to shade windows for summer**  
Sustainability Victoria  
www.sustainability.vic.gov.au and  
Shading Your Home  
www.yourhome.vic.gov.au

**External shading devices**  
Ecospecifier  
www.ecospecifier.org

**Other Fact Sheets in this series are also available to provide guidance on the 10 Key Sustainable Building Categories. For further information on Sunshading, consider the fact sheets entitled:**  
• Indoor Environment Quality  
• Energy Efficiency  
• Urban Ecology

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**Mandatory Requirements and Council’s Design Advice**

**Mandatory requirements**

- NCC Part 3.12 and Section J shading to walls and windows.
- Overlooking in clauses 54 and 55 of the Victorian Planning Provisions (VPP). 54.04-6 and 55.04-6 Overlooking Objective. Confirm these requirements before lodging your planning permit.

**Council’s Design Advice**

A window and shading design that balances undesired heat gains in summer and desired heat gains in winter and also maximises daylight penetration throughout the year.  
Show on Planning Application Drawings  
External fixed and flexible shading devices.

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