# Chapter One

## INTRODUCTION TO THE INFORMATION HANDBOOK

**Including:**

- **Why energy efficiency measures for Housing were introduced**
- **An outline of the use of the Information Handbook**
- **A description of the content of each Chapter within the Information Handbook**

## Contents of Chapter One



# 1. Introduction

The Australian Building Codes Board (ABCB) and the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) have developed this information handbook to inform people who use the Building Code of Australia (BCA) and may be affected by its greenhouse gas pollution reduction measures.

Source: www.yourhome.gov.au

The ABCB has prepared this handbook in conjunction with a wide range of stakeholders, including representatives from State and Territory Administrations and many industry organisations.

The handbook is based on material presented at national seminars by the ABCB and can also be used as a stand-alone information tool on how to work with the new measures.

If you have any queries about the information included in this handbook, the ABCB Office would be happy to assist. Contact details are telephone: 1300 134 631 or e-mail: abcb.office@abcb.gov.au

**AN IMPORTANT NOTE:**
**This Document is about the national BCA and does not contain State or Territory variations or additions**

# 2. Background

Since 2006, the BCA has contained energy efficiency measures for all building classifications. The inclusion of energy efficiency measures in the BCA is part of a comprehensive strategy being undertaken by the Australian, State and Territory Governments to reduce greenhouse gas (GHG) emissions.

Climate change is an issue of major significance for all of us. Most of the world's leading scientists agree that climate change is occurring due in large part to human activity. This presents challenges for the way we live and work and will require action from industry, governments at all levels, the broader community, and individuals.

On 20 November 1997, the Prime Minister released a statement: "Safeguarding the Future: Australia's Response to Climate Change". In this statement, a range of measures were announced to address global warming including the need to seek energy savings from the built environment through the introduction of mandatory minimum energy performance standards for all classes of buildings. After a period of consultation with the building industry and key stakeholders, the Australian Government announced in July 2000 that all State and Territory Governments had agreed to introduce mandatory energy efficiency standards into the BCA in order to reduce GHG emissions attributable to the operation of buildings.

The first stage of this initiative was to introduce energy efficiency measures into the BCA Volume Two on 1 January 2003. The next stage was to introduce energy efficiency measures for multi-residential buildings into BCA Volume One on 1 May 2005.

The next stage was to introduce energy efficiency measures into the BCA Volume One for BCA 2006. Also in 2006, the provisions for housing were increased in stringency to 5 star or equivalent.

In 2009 the Council of Australian Governments (COAG) announced that it would ask the ABCB to further increase the stringency of all buildings; for housing to 6 star or equivalent level. DEWHA is the lead Commonwealth agency responsible for managing this project and for future energy efficiency framework projects.

## 2.1 What are greenhouse gases?

GHGs are a natural part of the Earth's atmosphere. They trap the sun's warmth and maintain the Earth's surface temperature at a level necessary to support life. The problem we now face is that human activities, particularly the burning of fossil fuels (such as coal, oil and natural gas) and land clearing, are increasing the concentrations of these gases in the atmosphere, causing global climate change.

## 2.2 What are the effects?

There is now little doubt that climate change is occurring. Temperatures, rainfall and known climatic patterns will change. The impacts may be both positive and negative, affecting the distribution of plants and animals, the frequency of storms and floods, and the spread of weeds, pests and diseases which may influence agriculture and our health.

## 2.3 Why regulate buildings for energy efficiency?

While the building sector is not the largest contributor to GHG emissions, it is one of the fastest growing sources. Energy used in buildings accounts for almost 27% of all energy related GHG emissions.

Residential sector energy consumption is estimated to have grown by between 1990 and 2008. Projections to 2020 suggest an increase of 56% over 1990 levels. Improving the energy efficiency of buildings therefore represents one of the most cost-effective ways to reduce GHG emissions in Australia.

The use of renewable or low greenhouse intensity fuels can also reduce the greenhouse emission rate.

Consequently, our industry has an extremely important role in contributing to the abatement of Australia's GHG emissions and in delivering economic, as well as social and environmental benefits to the community.

## 2.4 How is energy efficiency being progressed in our industry?

A multi-pronged approach has been adopted by the Australian Government to improve the energy efficiency of buildings. Firstly, support has been provided by Government and industry for the introduction of minimum energy efficiency Performance Requirements in the BCA which are aimed at setting a community standard. Secondly, industry and consumers are being encouraged to embrace voluntary best-practice initiatives and thirdly minimum energy performance standards have been developed for major items of equipment used in buildings. Finally the Federal and State governments have a range of programs aimed at improving the energy efficiency of the building stock.

DEWHA is assisting industry through the development of practical guide material and associated training courses that help building design professionals and other building practitioners meet and exceed mandatory minimum standards. More information on each of these initiatives can be found at: www.environment.gov.au

In recent years the ABCB has also commissioned and prepared many technical reports that have informed the energy efficiency provisions. These can be found on the energy page of the ABCB's website at www.abcb.gov.au


## 3.0 Information Handbook Objectives and Structure

### 3.1 Objectives

The objective of this information handbook is to provide details of the relevant parts of the BCA and in particular the more recent changes. In highlighting key issues, the package gives practitioners sufficient knowledge to successfully apply energy efficiency measures at the design, approval and construction stages of the building process.

The information handbook has a practical focus. In addition to giving adequate theoretical knowledge, the handbook is intended to provide an understanding of the policy objectives and the technical basis of the BCA requirements. This will enable practitioners to competently manage a range of situations where different design and assessment tools are needed.

## 4.0 What is energy efficiency

### 4.1 What is energy?

For the purposes of the BCA energy efficiency measures, “energy” is the electricity, gas, oil or other fuels used in buildings for heating, cooling, lighting, hot water supply and the pumping of swimming pool and spa water. It refers to operational energy and does not consider the energy embodied in building materials or invested in the construction and recycling of buildings. The BCA measures for housing do not cover energy used by portable appliances (such as refrigerators, home computers and the like). Some appliances are subject to separate Minimum Energy Performance Standards (MEPS).

Producing electricity or burning natural gas and other fuels releases greenhouse gases into the atmosphere unless the energy source is one of the few considered “clean” sources, such as photovoltaic cells, hydroelectric or wind driven generators. Even these sources will be responsible for emissions at some part of their life cycle. The BCA recognises low-emitting energy sources in its Performance Requirements, Verification Methods and Deemed-to-Satisfy (DTS) Provisions. Since most of the energy consumed in houses comes from greenhouse gas emitting sources, reducing energy use will also reduce emissions and their unwanted impacts.

### 4.2 What is energy efficiency?

Energy efficiency is the prudent use of energy resulting from both regulatory measures and voluntary choices, in comparison to the amount of energy that would otherwise have been consumed. Reducing energy consumption by making houses less comfortable and less amenable would result in energy savings but would lead to a lower quality of life, lower personnel output in a commercial environment and possibly poor health. Using less energy for heating, cooling, lighting, supply of hot water, and the pumping of swimming pool and spa water while maintaining expected standards in these areas is the desired outcome. This is the aim of the BCA measures.

Energy efficiency for housing means reducing the load on equipment that directly consumes energy (such as heating and cooling equipment) and the ways that heat flows into and out of the house through its enclosing fabric. This heat flow determines how hard the equipment has to work. Better fabric thermal performance can mean smaller equipment, running for less time.

The stock of houses grows every year and houses remain in use for many decades. Adding houses with poor energy efficiency to the stock means that greenhouse gas emissions will continue to increase and their impact will be felt for a very long time.

## 5.0 Philosophy of the BCA requirements

### 5.1 Achieving energy efficiency through the BCA

Since 2003, the BCA has included Performance Requirements, DTS Provisions and Verification Methods with the objective of reducing greenhouse gas emissions by efficiently using energy and by using renewable energy from low greenhouse intensity sources. Housing measures were introduced first, followed by measures for Class 2 and 3 buildings and Class 4 parts and finally, other building classifications. The Deemed-to-Satisfy Provisions cover-

- insulation to the house fabric (roof, walls and floor);
- measures to control unwanted heat gain or loss through glazing and roof lights;
- measures to reduce air leakage (infiltration) through the envelope and through penetrations of the house fabric such as chimneys and flues;
- measures to facilitate air movement for cooling;

- insulation to hot water supply piping and heating and cooling piping and ductwork;
- measures to reduce greenhouse gas emissions resulting from heaters used for hot water supply systems, electric space heating, artificial lighting and heating and pumping of swimming pools and spas.

The philosophy underpinning these provisions is reasonably straightforward. A number of benefits are obtained by having a house that has better thermal performance. It is likely to stay warmer in cold weather and cooler when the weather is hot. This can reduce the size of any equipment needed for heating and cooling and the occupants are less likely to feel the need to run the equipment. Improving the efficiency of the equipment itself means that it will consume less energy when it is used.

### 5.2 Isn't this all about occupant comfort?

Not directly, but if we can produce houses with fabric that keeps conditions inside comfortable for the occupants, they will be less likely to use heating or cooling services, thereby reducing energy demand and greenhouse gas emissions.

However, optimal comfort is not specifically the objective of the BCA. Nor is it directly reflected in the Performance Requirements or DTS Provisions. Making houses inherently comfortable is a by-product of the overall BCA energy efficiency measures.

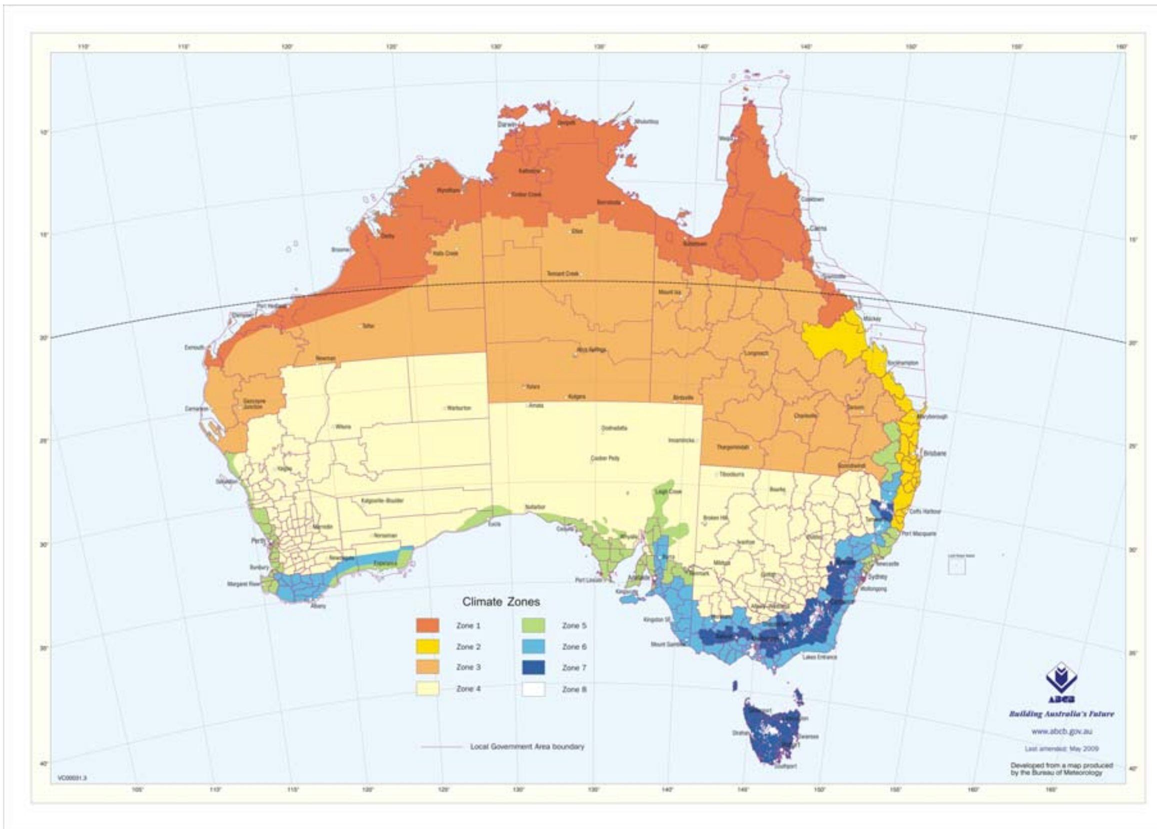
## 6. Basis of Energy Efficiency in Warmer and Cooler Climates

The DTS Provisions have two approaches. One uses the software of the Nationwide House Energy Rating Scheme (NatHERS) which recognises 67 distinct climate zones. The other approach which is much more prescriptive and less flexible contains building solutions based on eight climate zones (Refer to **Figure 1.1** for the extent of these climate zones). With both approaches there are different elemental DTS Provisions for each climate zone.

Note that the **Figure 1.1** climate zone map is based on both climate data and local government boundaries, so it may change from time to time in response to changes in those local government boundaries. The more numerous NatHERS climate zones are based on both climate data and postal districts.

**Figure 1.1** climate zones 1 and 2 are assigned to locations with hot or warm and humid summers and warm or mild winters where a desire for cooling is likely to predominate for most of the year.

**Figure 1.1 – Map of the eight elemental DTS climate zones**




Climate zones 3 and 4 have hot dry summers and warm or cool winters so that both cooling and heating may be desirable. In climate zone 4, a need for heating is likely to be felt for more of the year than a need for cooling.

Climate zone 5 is considered a warm temperate climate with limited need for cooling or heating although, in balance, the need for heating is likely to be greater.

Climate zones 6 and 7 are considered to be cool temperate climates respectively, with the winter cold enough to require significant heating.

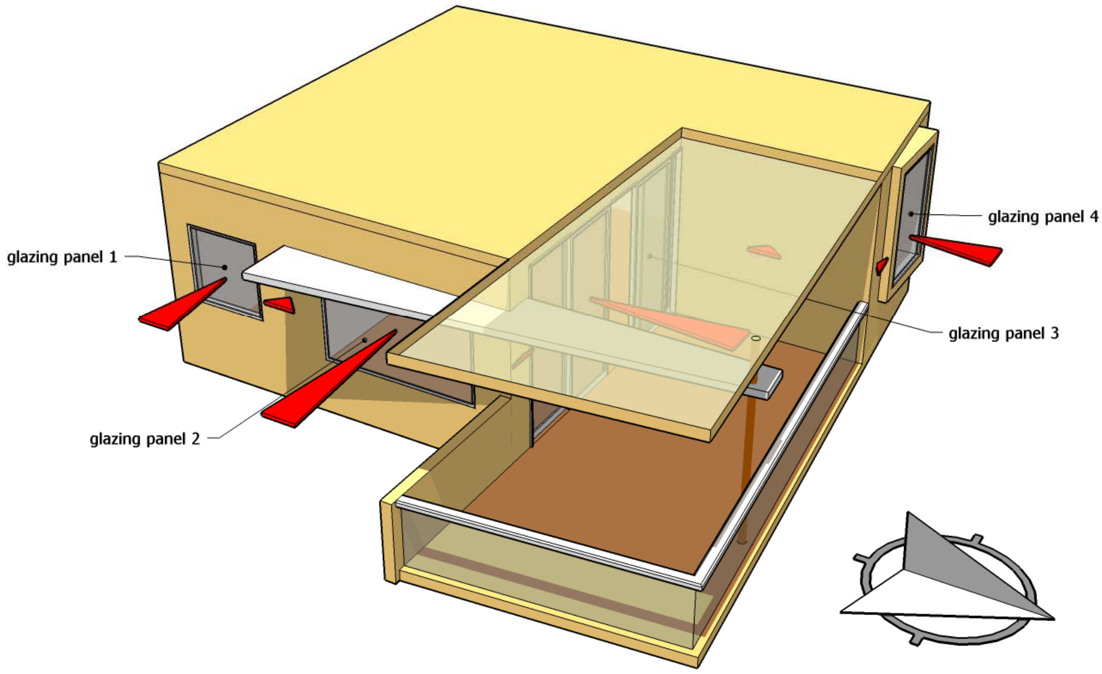
Climate zone 8 is an alpine climate where heating is the predominant need.

### 6.1 The approach to energy efficient buildings in warmer climates

For our hotter or warmer climates, climate zones 1, 2 and 3, the intent is to limit the need for cooling services (which use electricity which has a higher greenhouse gas intensity than natural gas). In these climates, heating is needed less frequently if at all.

The BCA elemental DTS Provisions for these locations, such as thermal insulation, favourable orientation and shading of glazing, sealing against air infiltration etc., are primarily aimed at reducing unwanted heat gain. Unwanted heat gain may increase discomfort levels in the building to a point where the occupants would want to turn on an air-conditioning system. Untreated glazing can be the main avenue for unwanted heat gain in summer or throughout the year in the hottest climates. This is shown diagrammatically by the size of the arrows in **Figure 1.2** which illustrates typical heat flows through the fabric and glazing of a bungalow over twenty four hours in January. Section 7 of this Chapter discusses in detail the impact of glazing.

**Figure 1.2 – Net daily heat gains through walls and glazing in summer**
*(average January day in Brisbane, balcony facing north)*



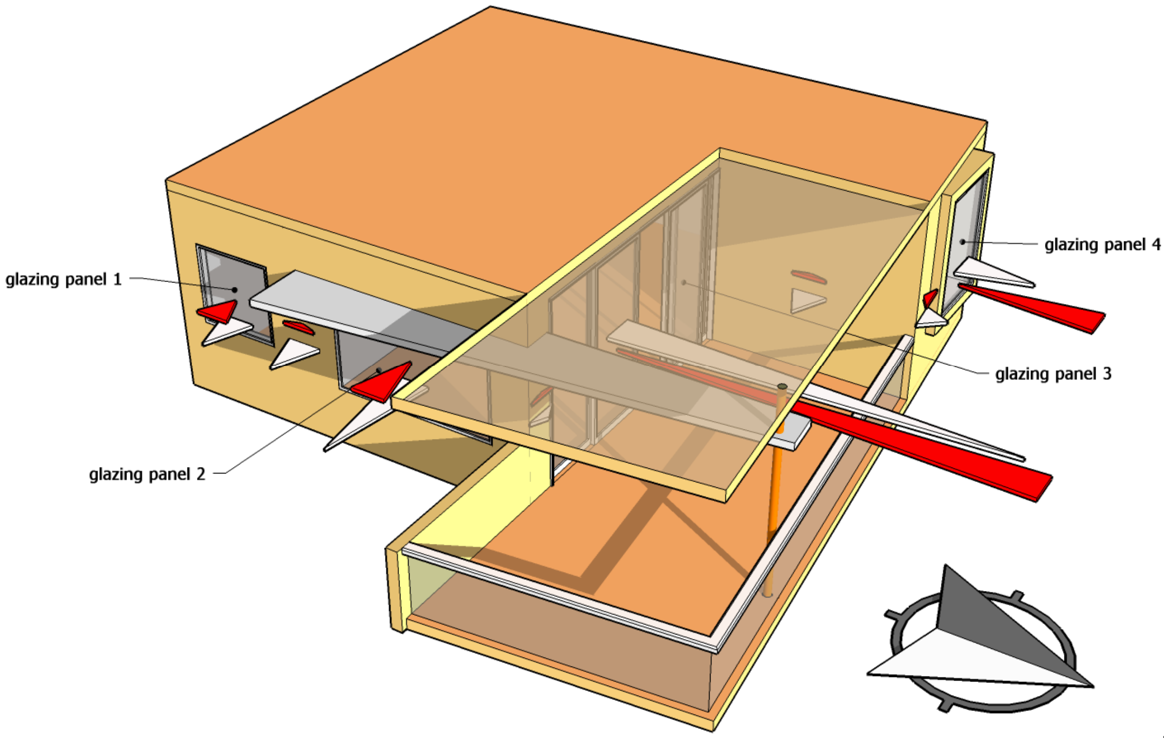

The relative net gains through glazing and insulated walls are indicated by the length of the arrows. No transfer through the ceiling or floor is shown because there are other Sole-Occupancy Units above and below. Note that the greatest net gains are through the east facing glazing panel 2 although it is not the largest area of glazing.

## 6.2 The approach to energy efficient buildings in colder climates

The coldest climates are found in climate zones 7 and 8. Climate zone 8 is the only strictly alpine climate and even it is much milder than alpine locations in other parts of the world. For houses in these cold climates, the intent is primarily to reduce the need for heating services although there may still be some use of cooling services as well in commercial buildings with a high internal load from computers and process plants. Provisions addressing the thermal insulation of the envelope, the size and type of glazing used, the level of air infiltration etc. are mainly aimed at reducing unwanted heat loss through the envelope, while making use of wintertime solar gains.

External glazing can be the main avenue for heat loss due to conduction through the glass and frame unless they have enhanced insulating properties or are oriented to make good use of winter sunshine. Refer to **Figure 1.3** (showing Hobart) and to Chapter 7 which describes the elemental DTS Provisions that regulate the performance of external glazing to reduce this heat loss.

**Figure 1.3 – Daily heat gains and losses through walls and glazing in winter**
*(average July day in Hobart, balcony facing north)*




The relative heat flows are indicated by the length of the arrows. Lighter arrows indicate solar heat gains and darker show conducted heat losses. (The lower arrow is always the larger). Heat losses through all walls and glazing exceed the gains except for the north facing glazing panels 3 and 4.

Heat loss without offsetting solar heat gains may cause temperatures in the building to drop to a point where the occupants will turn on the heating system. Reducing heat loss (via the envelope) and promoting natural heat gains (via the windows receiving winter sun) in a building located in a cold climate can reduce the need for heating services.

## 6.3 The approach to energy efficient buildings in temperate climates

Many Australians live in areas that have four seasons a year. These areas are found in climate zones 4 to 6, with even climate zone 2 in this category to some degree. These climate zones have warm to hot summers and cool to cold winters. Spring and autumn temperature ranges are generally mild. Building conditioning systems will, at different times, have a need for both heating and cooling to cater for the extremes of the seasons and, therefore, the BCA measures address both heating and cooling.

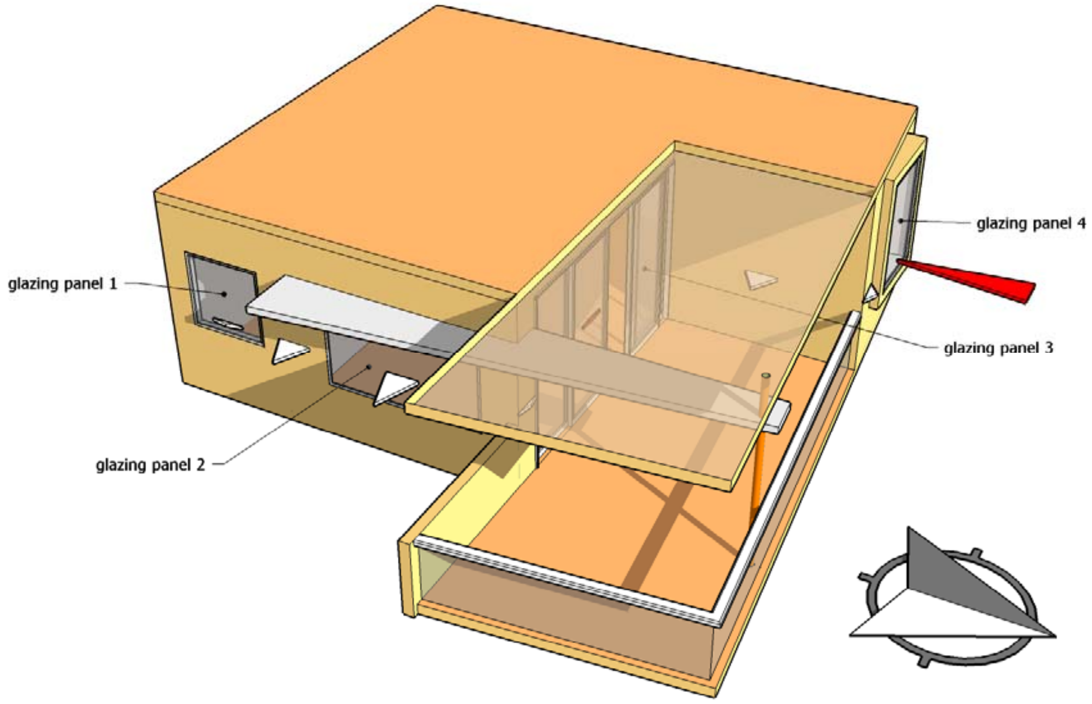
Thermal treatment of the building envelope is beneficial in both hotter and colder weather. In summer, limiting heat gain can reduce the desire of occupants to run any cooling services installed. In winter, the building fabric can reduce the heat loss (via conductance) to the outside and can also promote solar heat gains (through good orientation and treatment of glazing) to offset the conductive heat losses.

Refer to **Figure 1.4** as an example showing the net result of inward and outward heat flows over the 24 hours of a typical winter day through the fabric and glazing of a Class 2 sole-occupancy unit in Sydney in July.

***Design alert:*** *Remember, some cooling or heating services are likely to be installed in buildings. The BCA measures are attempting to reduce their use or how hard they work, not eradicate them.*

Glazing has many variables that can affect its thermal performance in both hot and cold seasons. The next section of this Chapter will cover the energy efficiency opportunities for fabric, including glazing.

**Figure 1.4 – Net daily heat flows through walls and glazing in winter**
*(average July day in Sydney, balcony facing north)*




Note that lighter arrows indicate solar heat gains and darker show conducted heat losses. All surfaces produce net heat losses except the north facing glazing panels 3 and 4. The net gain for glazing panel 3 is tiny. The largest net loss is through the east facing glazing panel 2.

# 7.0 The Importance of Glazing

## 7.1 The importance of glazing in houses

All elements of a house's fabric present opportunities for energy savings. It should be noted that the higher the floor above the natural ground, possibly to capture a breeze, the greater the wind pressure, and as a result, the greater the potential for infiltration or leakage through the building envelope and around glazing.

The BCA measures emphasize the importance of maintaining the thermal performance of the fabric, and this is highlighted in the Verification Method V2.6.2. Heating and cooling equipment may be replaced many times over a house's life but fundamental fabric measures such as wall insulation, window sizes, shading, orientation and air tightness need to remain for the life of the house.

For a unit or space with limited external fabric, glazing can become the greatest source of heat transfer and of infiltration or air leakage, making it the critical element in achieving energy efficiency.

## 7.2 The importance of glazing generally

Some glazing systems commonly used in Australian houses can have thermal insulation qualities that are poor compared to other parts of the house fabric. We heavily insulate some elements of the bounding envelope of our houses (such as walls, floors and roofs) against heat transfer yet significant heat transfer can occur through the windows unless drapes and shading devices are managed appropriately.

***Design alert:*** *For climate zones 2 to 7, external walls of a house may have a Total R-Value of around R2.8 while basic clear single glazing in an aluminium frame with a U-Value of 7.9 equates to an R-value of 0.13 (the reciprocal of the U-Value, 1/7.9). Therefore the external wall insulates over 20 times better than the basic, clear, single glazing.*

In summer, sunlight radiates through the glass, bringing unwanted heat into the interior. However, in winter, solar heat gains through the glass can contribute usefully to the energy efficiency of a house where heating is desired.

The provisions contain requirements for the thermal performance of glazing (including frames) depending on the glazing area, its orientation and the extent of any shading. This attempts to limit unwanted heat gain into the house in hot weather without unduly restricting the potential for solar heat gains in winter.

## 7.3 Glazing – the main opportunity to improve energy efficiency

Poorly designed glazing can become the main thoroughfare for unwanted heat gain or heat loss. However, with the correct design, windows and glazed doors may provide an opportunity to achieve greater energy efficiencies within the house by-

- maximising solar heat gains in cooler seasons lessening the need for heating;
- minimising unwanted heat gains in hotter seasons lessening the need for cooling;
- opening the house to air movement for cooling during the night in hot seasons; and
- providing natural light which can reduce the use of heat-producing artificial lighting in the house during daylight hours.

***Design alert:*** *One of the main considerations in the design of mechanical equipment for a house is the heating or cooling load resulting from the glazing. Correctly designed glazing may reduce the size and capacity of the heating and cooling equipment needed in a house.*

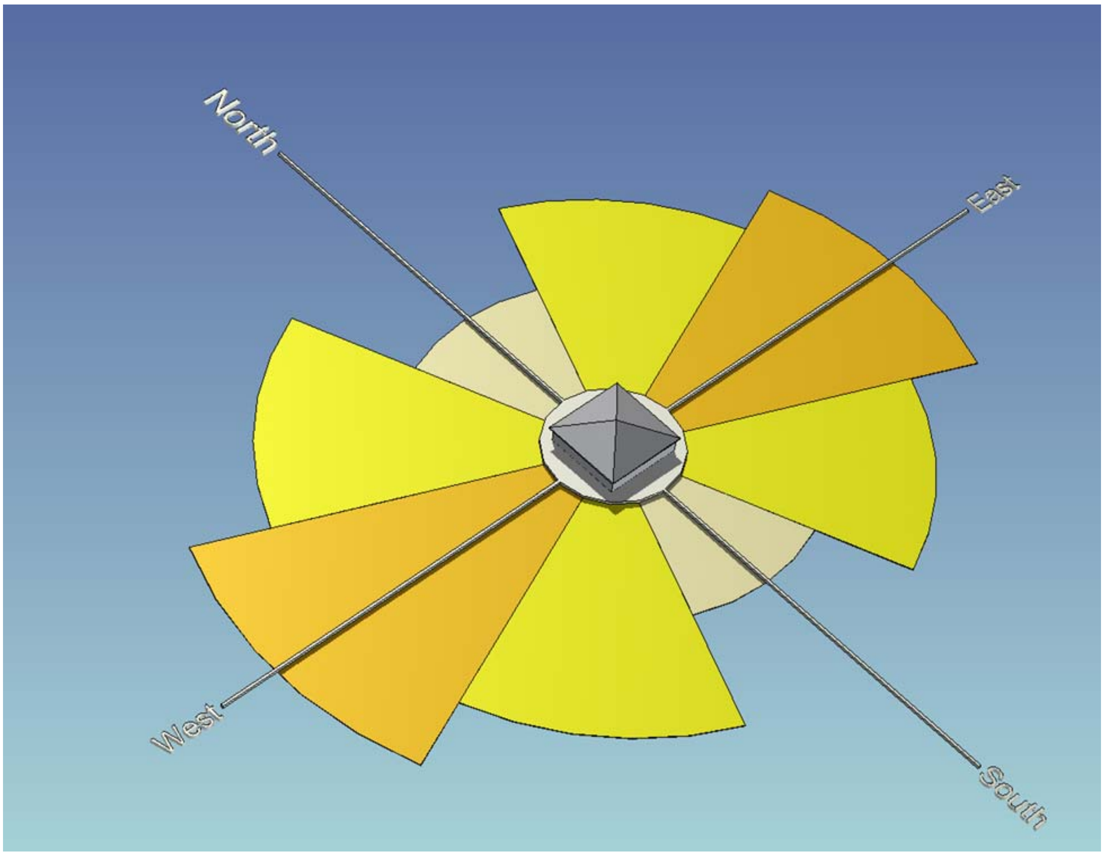
If used carelessly the glazed elements risk becoming a major weakness in the insulated building envelope. The provisions in BCA Volume Two under Part 3.12.2 are intended to keep unwanted energy flows through the glazing within limits that are considered reasonable for each climate zone. In some house types in some locations, greater energy efficiency can be achieved by also making use of desirable solar gains in the colder periods.

## 7.4 The importance of orientation to glazing energy efficiency

A comparison between **Figures 1.5 and 1.6** illustrates how windows can receive beneficial winter sun but not unwanted summer sun.

**Figure 1.5** shows the relative size of the total solar gains from eight different orientation sectors through unshaded glazing in Brisbane during the three months from December to February. The centrelines of the main sectors (North, South, East and West) are marked by solid lines. The sectors in-between align to North East, South East, South West and North West. The length of each "pie slice" shows the relative amount of solar gain from that direction.

**Figure 1.5 – Relative solar gains from eight different orientations during summer**



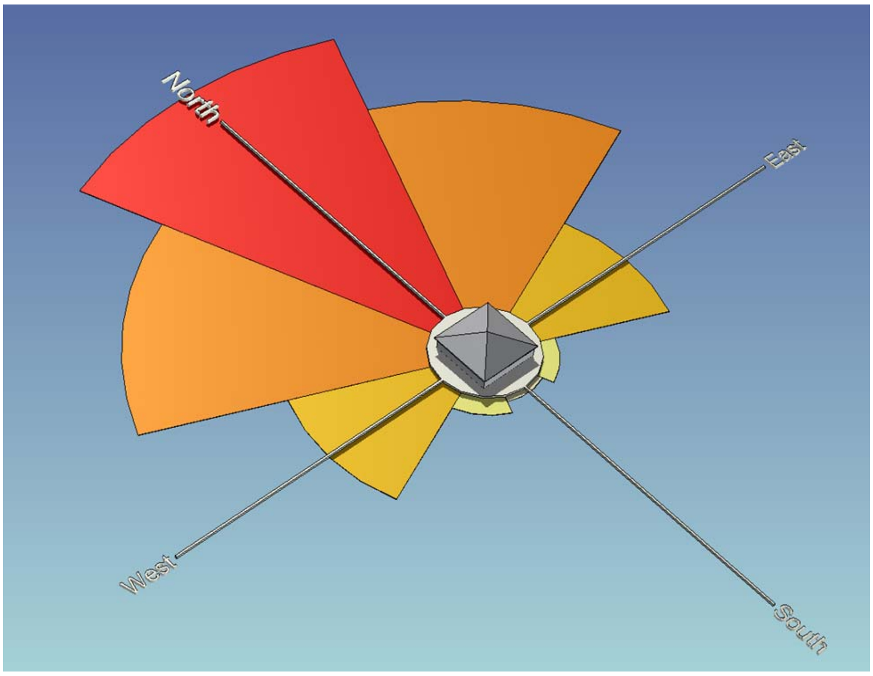

**Solar gains accumulated between December and February in Brisbane**

It is obvious that glazing facing the North or South sectors receives the least solar energy and much less than glazing facing the East and West sectors. (In fact, North or South facing glazing receives just half of the summertime gains of East and West facing glazing).

Gains from any of the intermediate sectors are about equal to each other and closer in size to the East and West gains than they are to the North and South. Although the diagram illustrates the situation in Brisbane, the pattern is broadly similar in most other Australian locations. It suggests that the North and South orientation sectors are particularly favourable for summer conditions.

**Figure 1.6** is the wintertime version of Figure 1.5, showing the relative size of the total solar gains from the same eight orientation sectors in Brisbane during the three months from June to August. It is drawn at the same scale as the summertime diagram so that the size of "pie slices" on both diagrams can be compared directly.

**Figure 1.6 – Relative solar gains from eight orientations during winter**




**Solar gains accumulated between June and August in Brisbane**

What might be unexpected is that the North sector is the largest source of solar gain during winter and the East and West sectors provide energy gains that are less than half of those available from the North. This is a complete reversal of the summertime situation.

Gains from the intermediate North East and North West sectors again fall somewhere between the two. The remaining sectors (South East, South and South West) provide negligible gains during the months when they are most desirable.

Combining the summer and winter outcomes shows that the East and West sectors provide the highest level of unwanted summertime energy gains but less than half of this during winter when solar gains are likely to be beneficial. The South sector provides the lowest summertime energy gains but virtually no useful energy gains in winter.

By contrast, the North sector has the same advantage during summer as the South sector but is the best source of desirable solar gains during the winter months. This combination identifies the North orientation sector as uniquely favourable for avoiding heat gains when they are not wanted and being able to make use of them when they will be most beneficial.

The North East and North West sectors provide comparatively high levels of solar gains all year round, whether or not they are welcome. The South East and South West sectors have the disadvantage of high summertime energy gains with minimal compensating benefit in winter.

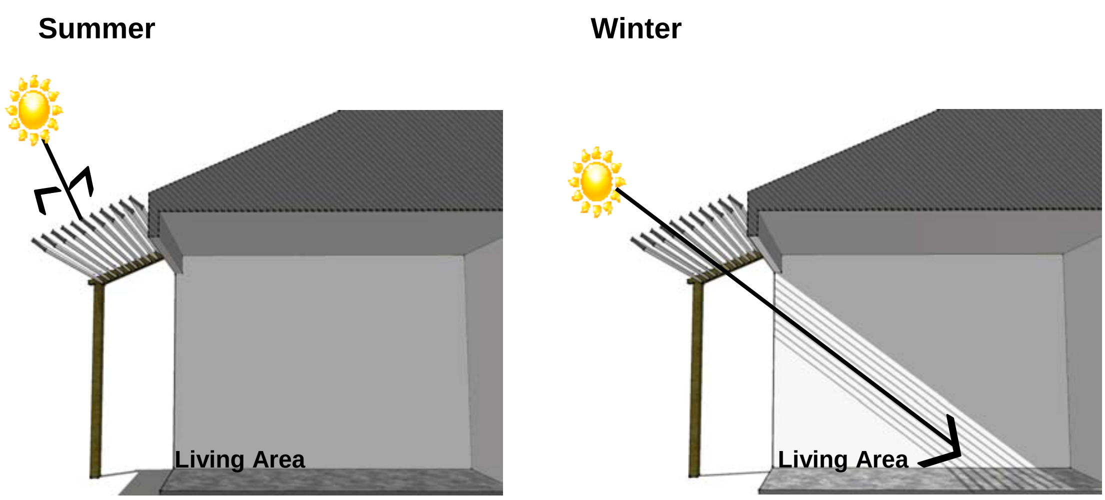
Orientation is not directly important for conductance. Whether a window faces North, South, East or West, the same amount of heat loss is calculated to occur because the loss depends on the air temperature inside the house compared to the air temperature outside, which is assumed to be similar in all directions. Good orientation, however, can compensate for heat lost through conduction by providing offsetting solar gains.

### 7.5 The effect of sun angles on energy efficiency through glazing

The winter sun appears lower on the horizon at any time of day than the summer sun at the same time. Between the lowest winter position and the highest summer position there is a difference of about 47°. For an unshaded window, the angle of the sun's rays onto the glass will affect the amount of solar heat gain transmitted through the glass. The sharper the angle (closer to 90° from the horizontal), the greater the reflectance from the surface of the glass, which results in less solar heat gain. This is most effective in summer as the sun is higher in the sky and thus the angle is sharper, whilst the winter sun is lower in the sky and the angle is more direct. The effect of this and the differing hours of sunshine between the seasons is reflected in the previous diagrams **Figures 1.5 and 1.6**, which illustrate results for unshaded glazing.

Another important benefit of the changing sun angles is that it is possible to provide shading devices that protect glazing from unwanted summer sun while allowing the lower winter sun to shine directly into the windows providing heat gains when they may be welcome (refer to **Figure 1.7**).

**Figure 1.7 – Shading effectiveness**




Source: www.yourhome.gov.au

## Conclusion

The purpose of this Chapter was to provide an overview of the parameters that affect house energy efficiency and an understanding of the basis of the BCA energy efficiency provisions. Read on for greater detail on the BCA provisions for housing energy efficiency.