OBJECTIVES

The objectives of this policy are:

(i) to provide advice on the principles of energy efficient building design, to improve comfort levels to occupants, and reduce energy consumption, and

(ii) to ensure buildings are well designed to achieve the efficient use of energy for internal heating and cooling

(iii) to ensure that design for good environmental performance and amenity is considered in conjunction with other design and amenity considerations in the Fremantle context.

INTRODUCTION

Buildings and the resources that are utilised to maintain working and living conditions, significantly contribute to the use and waste of resources, that have a negative affect on the environment. Simple measures can be implemented to improve energy use to enable the City to contribute to creating a more sustainable environment.

The intent of energy efficient building design is to reduce the need for energy consumption (electricity, natural gas, etc) for heating, cooling and lighting. Energy efficient buildings provide the benefit of:

- reduced energy costs for dwellings and commercial buildings (refer to Figure 1 for how power is consumed within a house),
- greater natural comfort and amenity level to building occupants, and
- by virtue of reduced energy; reduced emissions of carbon dioxide and other greenhouse gases, and thereby impact on the natural environment (this will also assist in achieving Fremantle's 20% greenhouse gas reduction goal).

Figure 1: Energy Usage in Houses.
Source: Western Power Corporation

Energy efficient design principles addressed in this policy include:

- building and room orientation,
- orientation, size and shading of windows,
- roof and wall insulation,
- use of thermal mass (heat absorbing) materials inside the house,
- cross ventilation and draft proofing and use of breezes,
- landscaping, and
- energy-efficient appliances.
POLICY

1.0 Application of this Policy

This policy shall apply to new development and extensions to existing buildings of all land use types, including residential, commercial and industrial. The requirements for residential buildings will be more critically considered as this forms the largest type of development in Fremantle, and the building’s occupants can derive the greatest benefit. Additional to providing guidance in the assessment of development applications, this policy is largely intended to provide information to the community.

It is acknowledged that circumstances may exist that limit the application of this policy, including the requirements of other Council policies, specifically:

- building and construction legislation (eg. Building Code of Australia), which takes precedence over this policy - in areas such as light, ventilation and construction materials and setbacks,
- lot orientation, streetscape and urban design considerations, particularly within established streets,
- cultural heritage considerations (ie. restrictions on design/materials having regard to the impact this may have on the heritage significance of a building or place),
- impacts on the amenity of neighbours (ie. setbacks and height of walls, overlooking from windows and upper level balconies),
- limitation on the height front fences - that otherwise are often used to screen front northern facing courtyards, and
- site topography and the desire to attain specific views (ie. prevailing winds, significant cuttings, the shape of the lot, and views to the river and ocean).

In these cases, or where other considerations may conflict with some of the requirements of this policy, each planning application shall be assessed on its individual merit. Consultation with Council’s planning officers is therefore encouraged prior to lodgement of an application. Designers and applicants should consider all relevant design criteria in a comprehensive manner, to achieve the best outcomes that serve these various requirements, including applicant’s own desired outcomes for their building and site.

This policy should also be read in conjunction with Council Policy D.B.M4 ‘Structure Plans and Subdivision (Green and Strata Titles)’, where the proper orientation of lots and development is encouraged in order to maximise a sites solar potential.

2.0 Energy Efficient Development Requirements

All new development, including significant additions (additions dealing with principle living areas, increasing the gross floor area by more than 50%, and 2 storey additions) shall be designed so that primary indoor and outdoor living areas (including courtyards and balconies), and primary work areas are orientated on the north side of the building to achieve maximum natural lighting and access to winter sun.

Full details relating to how these requirements can be achieved are contained in section 3.2, 3.10 and 3.11 below. Applications will be considered on their merit, with strategies for achieving a reasonable level or performance in the hands of applicants and their designers. The following guidelines are provided to assist in considering and developing these strategies and design solutions.

3.0 Energy Efficient Design Principles and Guidelines
Council encourages consideration and inclusion of the following energy efficient design measures when planning any development within Fremantle. This section is broken down into a description of the main areas of energy efficient design, followed by a series of recommended/preferred design controls.

Except where referred to in 2.0 above, this section is advisory only.

3.1 Site analysis

Preplanning of a site should consider constraints of existing surrounding and on-site development (such as overshadowing and overlooking), vegetation (overshadowing), natural factors (such as sun angles, prevailing winds and views), topography (slope) and streetscape. Refer Figure 2.

Once these are understood the basic orientation and building layout can be determined, including outdoor areas. Refer Figures 3 and 4.

![Figure 2: Site analysis - factors to consider. Source: City of Newcastle](image1)

![Figure 3: Allow adequate distance from obstructions to the north. Source: PATHE](image2)

![Figure 4: Place house well back from northern boundary. Source: PATHE](image3)
3.2 **Building Orientation and Layout**

Properly orientated buildings take advantage of the seasonal sun movement by allowing the winter sun into the building, but excluding summer sun (refer Figure 6). This has the effect of improving the amenity to habitable and working areas by accessing the natural heating, cooling and lighting elements.

During winter, the north face of the building receives significantly more solar energy (3-4 times) than east west sides. The northern side of the building is therefore a good location for living and primary working spaces that are continually occupied during the day, and which usually have the largest heating and lighting requirements. The time delay in heat penetrating the building also allows the benefits of such orientation to last well into the night.

The winter solstice (21 June) is a critical time to assess solar access, where at 12 noon the sun’s altitude (32°) casts shadow lengths 1.43 times the height of an object (by comparison, at the summer solstice - 22 December an object casts a shadow only 0.16 times its height). Refer Figure 5.

Conversely, the low angle of the sun in winter allows the greater penetration of direct sunlight into buildings orientated and designed to allow this, while the higher angle of the sun in summer allows it to be excluded.

![Figure 5: Objects cast shadows 1.43x their height in winter. Source: Office of Energy](image1)

![Figure 6: Paths of the Sun. Source: PATHE](image2)

Council’s policy D.B.M4 ‘Structure Plans and Subdivision (Green and Strata Titles)’ requires new lots to be solar orientated so buildings can maximise solar access.

Council’s policy D.B.H1 ‘Urban Design and Streetscape Guidelines’ also ensures that no overshadowing will occur to adjoining residential private open space or living areas for at least 6 months of the year.

**3.2.1 Preferred Controls**
(i) Indoor and outdoor living and entertainment areas (including courtyards and balconies) and primary work areas should be orientated, in order to optimise solar access. Refer Figure 7 and 8.

Figure 7: Solar access, orientation and floor plan layout. Source: City of Newcastle

Figure 8: Variable setbacks and solar access. Source: City of Newcastle
(ii) In order to achieve (i) above, and where room does not otherwise permit, areas in residential dwellings such as bedrooms, laundries, bathrooms, covered parking, storerooms may be located away from the northern aspect, as they have less heating and lighting requirements, particularly where they would otherwise prevent the northern orientation of main living areas.

(iii) Skylights or upper level windows and in some circumstances translucent roofs and glass bricks should be used to improve solar and natural light access (Refer Figure 9).

![Figure 9](image)

**Figure 9: Overcoming problems of winter overshadowing with upper level windows.** Source: PATHE

### 3.3 Window Location and Tinting/Shading

Design should take advantage of winter sun and provide protection from the severity of summer sun. The most effective way of controlling the overheating of a building, is to prevent summer sun from reaching windows. In the first instance, this should be achieved by well considered location and arrangement of windows. Use of appropriate shading/screening methods and glazing treatments will also be important. Unshaded glass will typically allow 86% of summer heat into a building, whilst shaded glass will only allow around 25%.

![Figure 10](image)

**Figure 10: Eves design exclude summer sun on north facing windows.** Source: Office of Energy

#### 3.3.1 Preferred Controls

(i) **North Orientated Windows:**
Living room windows should ideally face north to allow for efficient natural lighting all year round and solar warmth/heat gain in the winter months.

(ii) **Other Windows:**
Windows facing east and west should be more limited in size, treated with external vertical shading (eg. blinds, shutters, adjustable awnings appropriate to the building type), and/or tinted glass. Adjustable shading for eastern facing windows can allow for morning warmth to be gained in winter months.
Windows facing south can be used to provide a good secondary source of light without heat gain, however, the window size should be limited or insulated to reduce heat loss. South facing ‘clerestory’ type windows common in saw-tooth roofs of early industrial buildings are a good means for gaining indirect light without major heat loss (refer Figure 9).

(iii) Shade:
It is essential that north facing windows are shaded from the summer sun to reduce room temperatures, but permit winter sun for natural heating (between December to March). Refer Figure 10.

To enable complete shade in summer (between mid October to late February), eaves or shade structures such as external louvers over north facing windows, should have a minimum overhang of 0.45 times the distance from the eaves line down to the bottom of the window. North facing pergolas should be small or solar passive to block summer sun and allow winter sun to penetrate, ie. through angled louvers/battens, orientated to affect such shading (refer Figure 11). Alternatively, use of deciduous planting on pergolas can affect summer and winter control of sunlight penetration.

![Image of Solar Pergola](image)

**Figure 11: Operation of Solar Pergola. Source: Office of Energy**

3.4 Insulation

The Office of Energy (Western Australia) suggests that energy efficient house design can achieve an average internal temperature of 5°C Celsius warmer in winter and 10°C Celsius cooler in summer, than poorly designed homes. Insulation of a building can impact significantly on energy use, as 20% of all heating is lost through the roof. A combination of insulation techniques (floor, roof, wall) can reduce fuel bills by up to 40%. Refer Figure 13.

Insulation alters the rate at which a building loses or gains heat. Insulation is not a heat store, it just makes it harder for heat to pass through a wall, roof or floor.

R values, often shown on building materials, are a measure of insulation, that is resistance to heat flow (refer Figure 12). This is the ability to keep heat in or out depending on the season. If the R value is low the insulation potential of the subject material is low. The recommended insulation for ceilings is R2.5 - R3.5, for wall and floor a minimum insulation of R1.5.

The roof is the most important element to control heat gain/loss, and usually easiest and cheapest place to improve insulation performance of a new or existing building. The recommended R values below are for ceiling and wall insulation, not for the roof and wall
materials themselves. Ventilating the roof void above the insulation layer is an important method to disperse trapped summer heat.

3.4.1 Preferred Controls

(i) Minimum recommended insulation and treatments:
   - Insulation of roofs/ceilings: Minimum R value 2.5.
   - Insulation of walls/floors: Minimum R value 1.5 (east and west walls).
   - Adequate external shading or tinting of eastern and western facing windows.

(ii) Ventilating the roof void (above the insulation layer) via static or rotational vents should be utilised to disperse heat gain in summer.
(iii) Windows are a source of heat loss (and to a lesser extent heat gain) due to their low R value, and double glazing can be considered together with better insulation elsewhere as compensation. Considerable improvement can also be made with window treatments, especially well fitted lined curtains, with the base sealed by touching the window sill or floor, and the top partially sealed with a pelmet.

3.5 Thermal Mass and Building Materials

Thermal mass is a measure of a material’s ability to absorb and store heat. Generally, the heavier and more dense a material is, the more heat it will store, the longer it will take to release this heat, and the higher its thermal mass value/rating. Materials commonly used in construction such as concrete, brick and stone have a high heat storage capacity. Materials which are slow to heat up and take time to cool down, keep a building at a more even temperature.

In winter, the sun should be allowed to heat concrete floors and brick walls, where after sunset, the heat release will keep the buildings warm (refer Figure 14). Rooms will also remain warmer for longer (after switching off the heaters) than lightweight construction material, such as weatherboard. Equally, in summer, restricting the sun entering a building and from heating materials, will help keep a building cooler throughout the day.

The use and location of high and/or low thermal mass materials is not a simple issue and should be considered in conjunction with other design elements and the site context. The following environmental considerations should also be taken into account when selecting building materials:

- recyclable and reusable materials,
- renewable or abundant resources,
- durable materials with low maintenance,
- energy efficient materials with low embodied energy,
- non-polluting materials, and
- environmentally-accepting production methods.

Council encourages the sourcing of structural timbers from renewable resources (ie plantation or regrowth timbers, timbers grown on Australian farms, state forest plantations or recycled timbers) for building works, in preference to rainforest and old growth forest timbers.

3.5.1 Preferred Controls

(i) To be most effective, locate materials with a higher thermal mass inside the house; in north facing rooms, where they can benefit from winter heat gain; and where they are shaded from direct summer sun.
3.6 Ventilation

Natural ventilation relies only on natural air movement, thereby reducing the need for mechanical ventilation and air-conditioning (refer Figure 15).

Ventilation can be achieved in the following ways:
- cross ventilation, where air enters a building from one side passing out the other, replacing warm inside air with cooler outside air.
- the stack effect, where warm air rises through the height of a building, and is replaced by cool air at the base of the building.
- artificial ventilation, where fans are used to extract warm air allowing it to be replaced by cool air.

3.6.1 Preferred Controls

(i) Plan for easy flow of air through the house (breezeways). Rooms should have cross-ventilation (a door and a window opposite each other, or two windows opposite one another), a maximum dimension between openings of 14m is recommended.

(ii) Use high level windows or skylights which will allow hot rising air to escape, while retaining cooler air at lower levels. During cooler periods, these features will have to be sealed as winter heating will be lost.

(iii) Use ceiling fans to provide a high level comfort on most hot days, at low running costs. ‘Reverse cycle’ ceiling fans can be used during cooler periods to re-circulate warm air at ceiling level.
3.7 Colour

It should be noted that lighter colours reflect the sun’s heat whilst darker colours absorb it. This should be considered in determining colours especially for roofs but also for exposed walls.

3.7.1 Preferred Controls

(i) Roofs should be of light colour, except for white or other colours that may reduce amenity to neighbours through reflected glare (also refer also to D.B.H8 'Colour Schemes in Fremantle' for other building colour requirements). Traditional zincalume roofing is considered an acceptable ‘colour’ in this case.

Note that new traditional zincalume quickly fades after instillation, reducing the glare factor below that of white and other lightly coloured colourbond zincalume roof sheeting.

Figure 15: Integrated Dwelling Design Principles. Source: City of Newcastle
3.8 **Landscaping**

Landscape design is part of the wider design process for housing and needs to be considered from the beginning of a project so that its benefits are maximised for a building and its occupants. Landscaping can provide economic and attractive solutions to climate control, including providing shade and glare control in summer (provided that winter sun is not excluded). Refer Figure 16.

3.8.1 **Preferred Controls**

(i) Design houses mindful of existing vegetation which may be required to be retained for amenity reasons applicable to the site and the wider locality.

(ii) North and south facing windows should be kept clear of shading of the winter sun. Deciduous trees are ideal as they provide shade in summer but permit solar access in winter.

(iii) Trees and shrubs can be used to reduce heat gain through east and west walls in the summer. Tall evergreen trees on the west side of the house help shade that side from the hot afternoon sun but allow the sea-breeze to flow underneath. The selection of plant species should take into account the fully grown height and width of trees.

(iv) Landscaped and grassed areas tend to have reduced heat gain compared to paved areas and this can reduce reflected heating to the building. Paved areas can however provide a ‘warm’ island, useful in certain locations for winter use.

(v) Native and low water demanding plants can significantly reduce the need for sprinklers and reticulation. Over 60% of domestic scheme water use is directed towards the garden and lawns (not including private bores). It is encouraged that 85% of plantings in a new development are native species (for the Fremantle locale) or are drought tolerant (refer Council policies BSS31 ‘Tree Planting and Preservation’ and D.B.H4 ‘Landscaping/Tree Preservation within Development Proposals’ for landscaping requirements for new development).

![Figure 16: Landscaping. Source: PATHE](image-url)
3.9 Appliances

Where thermal comfort cannot be achieved through building design elements, there are many simple ways to reduce energy costs. The greatest opportunity to save is with services which use the most power, such as water heating, space heating and cooling (refer Figure 1). Water and room heating accounts for over 50% of home energy use and therefore solar hot-water systems and the use of gas for heating should be considered.

Fuel efficient appliances are encouraged and the improved efficiency coupled with the power consumption/amount of use should be considered in considering which appliance(s) to consider. Efficient lighting may actually only reduce power consumption slightly (as lighting only amounts to 4% of domestic power use) and switching unused lights off, or improving daylight to rooms may be more effective; hot water is a high power/consumption resource, as is refrigeration in many family homes.

Energy rating star system: This is the standard to compare the efficiency of different electrical appliances. The stars indicate how efficient the appliance is. The guide is, the more stars it has the better, up to a maximum of six.

The potential adverse visual impact of heating or cooling appliances on roofs, and adverse acoustical impact on neighbours should be considered with regard to the necessity, selection and placement of such units.

3.10 Residential Alterations and Additions

Residential alterations and additions can benefit from the energy efficiency and comfort of the whole dwelling, even when the existing dwelling is not upgraded. An energy efficient alteration or addition should employ passive solar design principles to maximise comfort and minimise household energy needs for services such as lighting and space heating in winter and cooling in summer (refer Figure 17).

Planning to relocate living areas to new portions of the house, better designed to perform effectively (and relate better to exterior spaces) should be considered in relation to older houses, where major living areas were more often poorly located and heavily enclosed, reflecting 19th century European design.

Figure 17: Principles for Energy Efficient Alterations and Additions.
3.11 **Heritage Alterations and Additions**

The preservation of heritage buildings and fabric may conflict with the goals of achieving energy efficiency. While the recommended controls should be considered in all dwellings, new and old, certain concessions may be necessary if the heritage fabric is to be retained. For example, whole or partial removal of internal feature walls in order to improve cross-ventilation may be detrimental to heritage values. Similarly, roof mounted solar collectors and storage tanks may not be desirable elements. However, there are numerous high efficiency hot water systems that can be installed either at ground level or in the roof and still achieve an energy efficient outcome. Improving a heritage property’s thermal properties should still be achievable without detrimental impacts on heritage values. The best way of achieving this should be determined on a case-by-case basis. For example, installation of ceiling insulation and double glazed windows, laying polished timber floors on concrete slabs (in additions), and insulating the walls of new additions, are possible means of improving energy efficiency without compromising heritage values.

Reallocation of room uses is a primary means of improving the total comfort and performance of an extended heritage building. The solid material and construction of many old masonry buildings may be of considerable benefit in achieving energy efficiency. Insulation of timber framed houses (walls and roof spaces) is also particularly effective in improving the performance of these types of buildings. Sealing of gaps to walls, roofs, ceilings and to openings will significantly improve thermal and acoustic performance, by preventing leakage of air.

Care should be taken however, in dealing with any original fabric to avoid excessive damage, with surfaces to be made good - consistent with the originals.

4.0 **Alternative Power Sources**

Alternative power sources to the metropolitan electricity grid are available and include solar and wind generation. Contact the Office of Energy and Western Power Corporation for further information.

5.0 **Further Professional Advice**

Designing buildings for energy efficiency may require detailed advice. It is important to seek appropriate professional advice in the implementation of the principles outlined in this policy. Individual sites and circumstances, coupled with individual personal priorities, will dictate different solutions or a range of solutions that will best suit.

While not exhaustive, agencies listed below can provide additional energy efficiency information.

**Government of Western Australia**
- Office of Energy (www.energy.wa.gov.au) (Home Energy Hotline 1300 658158)
- Water Corporation (www.watercorporation.com.au)
- Department of Minerals and Energy (www.dme.wa.gov.au)
- Department of Resources Development (www.drd.wa.gov.au)
- AlintaGas (www.alintagas.com.au)
- Western Power Corporation (www.wpcorp.com.au)

**Other State Government Departments / Regulatory Bodies**
- Department of Mines and Energy (Queensland)
- Ministry of Energy and Utilities (New South Wales)
- Office of Energy Policy (South Australia)

**Commonwealth Government Departments / Regulatory Bodies**
- Department of Industry, Science and Resources (www.dple.gov.au/resources.energy/energy/index.html)

**Industry Bodies / Associations**
- Alternative Technology Association (www.ata.org.au)
- Australian Cooperative Research Centre for Renewable Energy Ltd (www.aare.murdoch.edu.au)
- Australian Gas Association (www.gas.acn.au)
- Housing Industry Association (www.buildingonline.com.au)
- Australian Institute of Energy (www.aie.org.au)
- Chamber of Commerce and Industry (www.cciwa.asn.au)
- Chamber of Minerals and Energy (www.mineralswa.asn.au)
- Electricity Supply Association of Australia (ESAA) (www.esaa.com.au)
- CADDET Energy Efficiency Site (www.caddet-ee.org)
- CADDET Renewable Energy Site (www.caddet-re.org)
- GREENTIE (www.greentie.org)

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