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Revision History

Rev. No.	Date Changed	Modified By	Details/Comments
2	June 2013	Sustainability	Name change to 'Energy efficiency Design Guideline for Commercial and Industrial Development' to avoid any conflict with BASIX requirements for Residential development. Amendments to reflect contemporary State legislation and industry best practice.
01	12/12/2005	LMC^2 Consulting Group	General amendments to the document: ▪ Minor word changes to document. Changes related to introduction of BASIX, changes to NSW Government Departments as well as general errors and inconsistencies Section 2.0 Uneconomic Exemption Policy ▪ Deletion of entire section 2.0 Uneconomic Exemption Policy - Superseded by BASIX. ▪ Insertion of new Section 2.0 BASIX including information that DA's require a BASIX Certificate under the new legislation, with no provision to allow for uneconomic exemptions. Section 5.0 Buildings Site Layout ▪ Removed reference to "Scorecard"
Master	22/03/2004	LMC2 Consulting Group	Master Document - adopted by Council on 22 March 2004

Summary

Addresses issues in achieving energy efficiency in commercial and industial developments, such as site analysis requirements, building layout and construction techniques, and energy efficient appliances.

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1 INTRODUCTION

These Guidelines encourage the design and development of energy efficient and sustainable development in Lake Macquarie. It reflects Council's concern for the environment and the ecologically sustainable development of the City as well as the flow on effects of energy resilience and cost of living.

These Guidelines apply to all commercial and industrial development or subdivision in Lake Macquarie and requires all new development to comply with the following principles:

- Passive solar design.
- Orientation to north.
- Maximise north facing windows.
- External summer shading to east, north and west facing windows.
- Solar access to private open space.
- Roof, ceiling and wall insulation.
- Installation of solar water heaters.
- Water efficient practices and stormwater reuse.
- Waste minimisation and recycling.
- Energy Efficient Commercial buildings
- Energy resilience via renewable energy generation and embedded generation
- Net Zero Energy Buildings

1.1 PURPOSE AND FEATURES OF THE GUIDELINES

The Guidelines are designed to complement the Energy Efficiency provisions contained within Council's Development Control Plan (DCP).

1.2 AIMS AND OBJECTIVES

Aim

Council's DCP aims to encourage the design and construction of energy efficient and sustainable development in Lake Macquarie.

Objectives

a. To encourage site planning and building design that optimises solar access to land and buildings.
b. To encourage energy efficient subdivision design that allows the construction of solar and energy efficient buildings.
c. To reduce total energy consumption in buildings by the adoption of passive solar design principles.
d. To encourage the adoption of energy and water efficient building materials and practices that are environmentally sustainable.
e. To encourage waste minimisation and to increase the amount of material recycled from commercial and industrial buildings in Lake Macquarie.
f. To encourage water conservation practices and the reuse of stormwater.
g. To encourage renewable energy generation and energy resilience

2 BUILDING SITE LAYOUT

2.1 BUILDING LAYOUT STRATEGY

Setback design is a critical factor in maximising opportunities for solar access benefits to a building.

Buildings on lots on the north side of an east-west street should be positioned close to the street to maximise solar access behind them. Consideration may be given to a reduced street setback if required. However, consideration still needs to be made for car parking by staff and customers. Apart from the retention of adequate space, car parking can benefit from the shade provided by buildings, although summer shade will be minimal without additional awnings.

Buildings on east-west lots should be located close to the southern boundary to maximise opportunities for solar gain and natural lighting in cooler sessions.

2.2 DESIGN OPTIONS

This section is intended to assist applicants in understanding the range of design options that are available in building an energy efficient building.

Part A – Building Envelope

Orientation

- Design building specifically for its site, ie. locate northern wall to maximise solar access, and orient one of the building's axes between 30^{o} east and 20^{o} west of true solar north. Where this is not possible in existing subdivision, provide properly shaded north facing glass to open and occupied areas and maximise solar access by the use of site analysis including existing shadows diagram.
- When considering the orientation of the long direction or axis of north facing work areas, scores can be partially awarded for the proportion of total open and occupied areas facing north.
- Service areas (eg. toilets, storage areas, etc) are usually located on southern or western side, as they have minimal thermal comfort requirements. "Wet" areas (ie. kitchen, bathroom, laundry) are clustered to minimise hot water pipe runs .
- Circulation zones (eg. entries, corridors, halls) have minimum thermal comfort requirements; but will still generally benefit from the provision of solar access for natural lighting. Consideration needs to be given to how their temperature can impact on other zones if they are open between those zones.

Thermal Mass

- The construction material and the type of finish, such as whether it is in contact with the ground, sealed underfloor area or suspended and ventilated. Hard floor finishes are preferable because they thermally connect the air mass in the dwellings to the thermal mass in the earth below.
- The floor is commonly the most economical place to locate heavy thermal mass materials (eg. Concrete slab) & its thermal performance will be best in north facing rooms receiving direct sunlight.
- However, wall materials such as reverse brick veneer, cavity brick, concrete blocks, stone, mud brick, rammed earth and even contained water in walls, are also very useful in providing more comfortable internal room temperatures.
- Where external walls are lightweight and insulted, providing mass in internal walls minimised the daily temperature fluctuations and improves comfort considerably.

Shading

- External shading to North facing windows should provide maximum shading in summer and minimum shading in winter. This type of shading can be simply provided by incorporating eaves overhangs or fixed awnings designed to meet a 70^{o} (from the horizontal) line drawn from the bottom of the window to the eaves.

- Pergolas, verandahs and eaves to the western and eastern aspects should also be designed to maximise summer shade and where possible minimise winter shade, eg. By deciduous climbing vines on pergolas or operable louvres.
- Window shading devices suitable for all windows but particularly westerly and easterly windows include external blinds (fabric & louvre), shutters (both hinged & roller), awnings (both fixed & roller) and close fitting curtains

Glazing

The proportion of north-facing (30^{o} east to 20^{o} west of true solar north) windows in a plan compared to other aspects should be as close to 75% as the site and plan will allow. Buildings should be designed with more than 50% of all glass faces north or where high efficiency windows are employed. It is undesirable to have east or west windows predominate (unless they are shaded). Further, they should be either double-glazed or made from a high efficiency selective glazing material.

Skylights and Day Lighting

Skylight / daylight design needs to reflect the importance of providing suitable day lighting levels while avoiding unwanted heat gain or loss. To achieve this clerestories or skylights generally require some sort of shade device, either externally or internally such as with eaves or a solar blind. Further, they should be either double-glazed or made from a high efficiency selective glazing material.

Wall and Roof Colour

The roof is the dominant heat path however, wall colour is nonetheless important. Darker colours, in absorbing more heat all year have a bigger negative impact on summer comfort than they do a positive impact on winter comfort so are rated accordingly. The lighter the colour roof and walls the better. Additional heat can generally be collected by harnessing solar gain from windows when it is needed.

Landscaping

Council seeks to influence landscape planting to ensure that solar access is maintained to all buildings. By assessing which trees are likely to create unwanted shadows as they mature, future conflicts are likely to be prevented.

Ventilation and Zoning

- For summer conditions, a buildings openings should be designed to take advantage of prevailing wind direction; passive solar design not only takes advantage of cooling daytime breezes but depends on cool night-time ventilation to flush out the heat of the day so that the structure is cool for the next day.
- The effectiveness of built-in cross ventilation depends on placement of openings to create breeze pathways (or breeze-paths) with minimum obstruction. Openings in a room are best placed in opposite walls to create air movement across the room and maximise the effect in that room. It is an advantage to have a dwelling designed with 2 or more separate breeze-paths exist and are relatively obstruction-free. Where multiple breeze-paths exist and are relatively obstruction-free. Where multiple breeze-paths are incorporated, effective ventilation can be achieved when wanted, irrespective of whether some doors might be closed.
- Ceiling fans provide assistance to both ventilation and personal cooling in summer.
- In winter, however, it is important to be able to close off areas, so that only those areas which need heating are heated. A building will save on winter energy if individual zones can be closed off.
- It is recommended that buildings provide an air-lock to main entry and / or exit doors, because of the significant amount of ‘conditioned’ air that can escape when doors are left open even for relatively short periods.
- An important feature to include when installing windows is that they be lockable in a partly open position, for ventilation and security.

Insulation

Floor

- As indicated above, floors in contact with the ground are thermally most efficient. Nonetheless, slabs lose heat around the edges and benefit from alb-edge insulation. Suspended floors, particularly of timber or sheet materials will often benefit from underfloor insulation, (concrete slab floors on ground only require under-slab insulation in cold climates or where the slab is used to centrally heat the dwelling).

Walls

- Walls represent a significant proportion of the external area of the building envelope and should be insulated. Bulk, lightweight insulating materials (eg. batts) are the most common choice for framed or veneer external walls. Insulation is most effected on the outside of thermal mass.
- Vapour barriers are sometimes recommended on the warm side of the insulation layer to keep moisture from condensing within the insulation in some climatic or air-conditioned situations, condensation within the insulation can dramatically reduce the effectiveness of insulation and the life of both insulation and the surrounding structure.
- Where reflective sarking is used, an effective R-value can be attributed and the bulk insulation level reduced accordingly.

Roof

The roof is a major heat path in all weather. The most appropriate insulation levels and type depends on climate. Location specific requirements may apply in different areas.

Ceiling

- The ceiling is also a major heat path in all weather. If the roof in uninsulated, the ceiling should be insulated instead.

- Where metal deck is specified manufacturer's recommendations often specify insulation blanket below the decking. Unfortunately, when installed under sheeting like this, bulk insulation compresses and loses some of its efficiency

Windows

- Windows can best be insulated internally by providing close-fitting, opaque curtains preferably with pelmets.

Seals

- It is recommended that doors and windows that have draught excluders and weather seals . Without seals the comfortable conditions within the building will 'leak' and be lost with consequent increases in energy consumption and cost.
- Exhaust fans vented to the exterior are used where moisture is present, but fans should have built-in shutters, to prevent draughts.
- Fireplaces and chimneys should have covers or dampers for the same reasons discussed in 'Seals' above.

Part B – Hot Water System and Space Heating and Cooling

Water Heating

- Hot water storage should be located close to the most-used hot water outlets and 'wet zones' should be grouped together, to shorten hot water pipe runs.

- Solar Hot water should be considered when suitable location for collectors are available

Space Heating and Cooling

- Design for space heating and cooling should identify individual zoning for heating and cooling. Heating and cooling zones should be individually controlled.
- Heating, ventilation and cooling (HVAC) systems should include an “economy cycle” where air from outside the building can be used for 100% of the building’s needs in lieu of active air conditioning for those periods where the temperature and humidity is appropriate.
- Insulate ducts to at least R1.5 and make sure all joints are well sealed
- Shade outdoor components from direct sun of mechanical cooling
- Mechanical heating and cooling should never be used as a substitute for good design.

3 BUILDING AND CONSTRUCTION

3.1 FLOOR LAYOUT

Principles

Zoning is a term used to describe the general arrangement of uses within a building. In an energy efficient building, utility rooms and spaces can be strategically placed to shield the more commonly used zoning from extreme climatic conditions.

The arrangement of rooms does not cost anything at the design stage but can significantly reduce heating and cooling bills and improve comfort levels. The building will be warmer in winter and cooler in summer.

3.2 ZONING

Identify the zones which will be occupied the majority of time. Place these zones along the north or the north east side of the building, where they will be warm in winter and cool in summer

3.3 LANDSCAPING GUIDELINES

Principles

- Trees are natures own cooling system. Planted in suitable locations they can reduce heat gain and ground temperatures by shading and reducing heat loss.
- Trees, shrubs, ground covers and vines can modify the effects of weather on a dwelling.
- Trees can increase the levels of comfort by shading a dwelling, particularly west facing windows and walls. Also they can provide outdoor shade during summer. West facing walls and/or windows can be protected by vines on trellises.
- Deciduous trees/vines planted on the north side will shade the building in summer but let the winter sun into the living area.
- Evergreen trees and shrubs could be planted on the east and west sides to give shade from the early and late sunshine.
- Evergreen trees should be located where they will screen the building from cold winter winds.
- Thick rows of trees and shrubs can help to deflect cooling breezes into the building in summer.
- Ensure that mature trees will not shade any solar electricity or water panels.
- In selecting trees and vegetation best suited to energy conservation, regard should be given to the following:

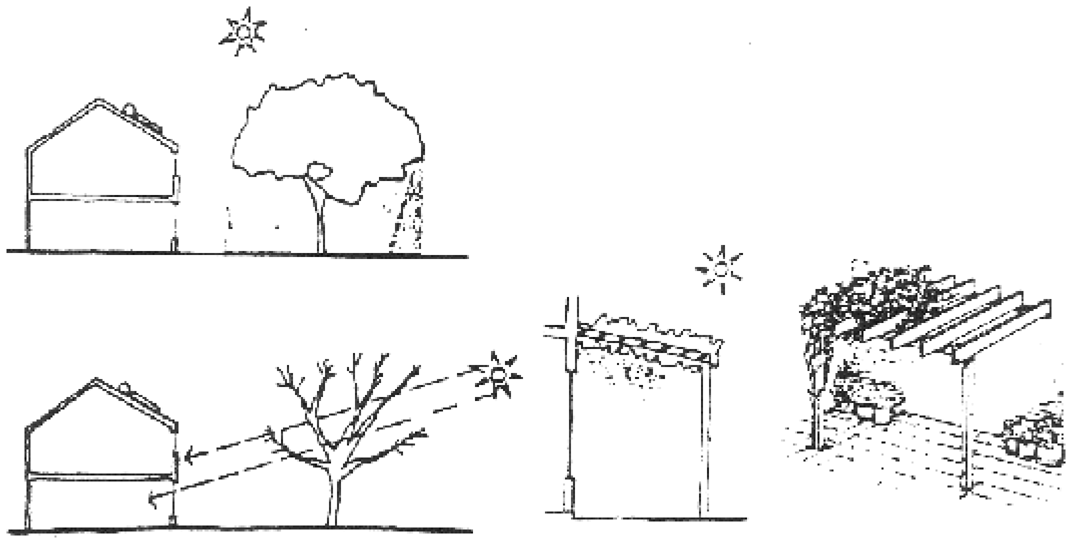


Figure 1 - Use of Landscaping

Guidelines –

- Design building to retain existing trees wherever possible.
- Treat every existing tree as a valued asset which contributes to the aesthetic and monetary value of the development.
- Use native deciduous trees on the north side of dwelling.
- Use ferneries, planted pergolas and vines near dwellings to help cool building in summer.
- Provide permeable paving surfaces instead of concrete or bitumen to reduce runoff and allow return of water to the water table.
- Use water efficient species wherever possible
- Use native species to maximise biodiversity and attract native fauna.
- Use plant species tolerant to local climate and soil conditions.

3.4 STORING HEAT

Principles

Thermal mass is a term used to describe a building's ability to store heat. A building with a lot of thermal mass will be able to store heat during the day in winter and return this heat to the space at night. In summer the building will absorb excess heat and keep internal spaces cooler.

Full Masonry Walls with Concrete Floor

This form of construction provides the most thermal mass. Some soft floor coverings should be used to moderate the effect of the mass and reduce echoes in the room.

Full Masonry Walls with Timber Floor

Building with cavity brick walls and a timber floor provides for a good balance of thermal mass within the rooms. Internal brick could be rendered, or replaced with timber stud walls in bedrooms.

Framed External (Brick Veneer or Weatherboard) Walls with Concrete Floor

External brick veneer does not add significantly to the thermal mass of the buildings as it is not in contact with the internal space. The floor slab will provide a fair amount of thermal mass provided it is at least partially covered with hard floor coverings such as slate or tiles. The ideal location for these hard floor coverings is in the north facing rooms, where it will receive maximum heat from the winter sun.

Framed External (Brick Veneer or Weatherboard) Walls with Timber Floor

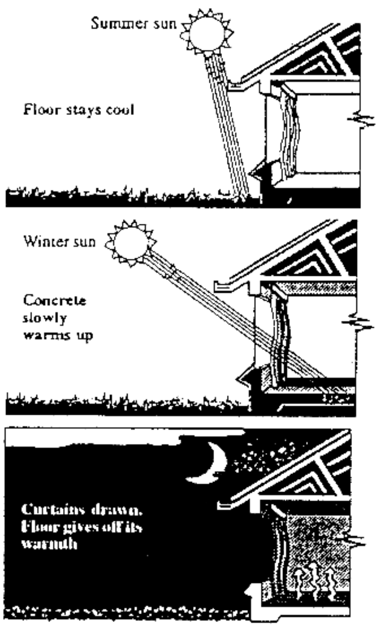
This form of construction provides very little thermal mass. The level of mass should be increased by including internal masonry walls in the northern living area. The area of internal masonry should be approximately the same floor area of the rooms with north facing windows.

Thermal Mass in Winter

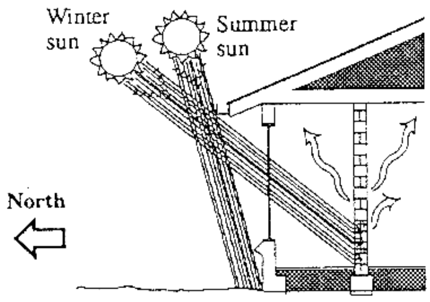
Allow as much sunlight to fall onto the thermal mass during the day in winter. This will mean locating thermal mass close to the north facing windows and opening the curtains of such windows on sunny days. The thermal mass will slowly begin to radiate the heat back into the room in the evening, cutting down on the amount of heat required from a conventional heater.

Thermal Mass in Summer

It is important to shade the thermal mass from the summer sun through the use of properly designed external shading (see Window Shading). Any heat built up within the buildings in summer will be partially absorbed by the thermal mass, making the buildings cooler during the day. At night windows should be opened to allow the night air to remove the heat from the thermal mass.



Concrete slab-on-ground as a heat store



Internal walls as a heat store

Figure 2 - Thermal Mass - Using concrete slab and/or internal wall as heat store.

Guidelines

Concrete floor slabs and internal brick walls absorb winter solar energy and summer ambient room warmth.

Designs should endeavour to exploit the beneficial thermal mass associated with those materials.

Use Thermally Massive Building Materials

Building materials that will help increase the thermal mass in buildings include:

- bricks
- concrete
- concrete block
- stone
- floor tiles and slate

Locate Thermal Mass as Follows:

- For thermal mass to work properly in moderating the internal temperatures, it is important that the thermal mass be in direct contact with the internal spaces. This means that :
  - concrete floor slabs should not be covered entirely with carpet or vinyl floor sheeting. Instead cover the mass with tiles or slate so that the internal mass stays in contact with the room.
  - brick walls should face into the rooms. Consider building brick veneer walls inside out. That is locate a Weatherboard stud wall on the outside of the skin of brickwork. Double brick walls could also be considered.
  - feature walls of brick or stone could be used in the living areas.
  - thermal mass should only be used in rooms which have winter sun entering.
  - Finishes for Thermal mass
  - Floor - tiles, brick, stone, etc.
  - Walls - cement render, tiles.

Insulating finishes like carpet, vinyl, cork, plasterboard should be avoided.

Quality Lifestyle Advantages

- Reduction in heating bills through storage of heat for the evening.
- The buildings will be more comfortable because it will be cooler in summer and warmer in winter.
- Solid masonry materials improve building longevity and fire resistance.
- Reduced energy consumption saves money and means a reduction in greenbuildings gas emissions.

3.5 INSULATION

Principles

Thermal Insulation

Building components and materials transmit applied heat to varying degrees. The process of reducing the rate of heat flow is called thermal insulation.

R Values

The value given to the insulating qualities of a material is its resistance or ‘R’ Value. The greater the R value the less heat will pass through the insulating material.

Types of Insulation

Examples of bulk insulation are:

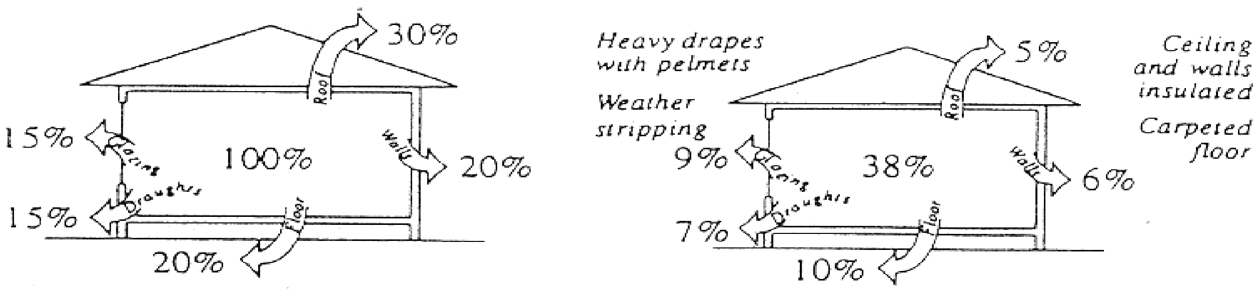
- Fibreglass Bats or Matting
- Mineral Wool
- Natural Wool
- Cellulose Fibre
- Expanded Polystyrene (EPS)
- Autoclaved aerated concrete blocks (AAC)
- Lightweight concrete with EPS aggregates

Examples of reflective insulation are:

- Reflective foil laminate

Examples of composite insulation materials are:

- Reflective foil bats
- Fibreglass with bond FR
- Ceiling Insulation



Uninsulated Buildings Insulated Buildings

Figure 3 - Heat losses from uninsulated brick veneer buildings compared to an insulated brick veneer buildings.

Much of the heat loss from the buildings occurs through the ceiling. Bulk insulation in the ceiling is a critical factor in reducing heating energy bills. Depending on the construction, insulation can be laid onto the ceiling, or under the roof material.

Reflective foil insulation can help to keep the buildings cooler in summer by reducing heat radiated down from the roof.

The recommended level of ceiling insulation for Lake Macquarie is: R 3.5 for heating only and R 4.0 for heating and cooling.

Wall Insulation

There is usually not as much heat gain or loss through the walls as through the ceiling, and so recommended levels of wall insulation are lower. It is important not to cut costs by not installing wall insulation, as it is difficult to install it later.

The recommended level of wall insulation in Lake Macquarie is: R 2.0 for brick veneer and Weatherboard walls and R 1.5 for cavity brick walls.

Floor Insulation

A concrete floor slab laid on the ground will generally provide enough insulation but will require edge or perimeter insulation. Suspended concrete and timber floors should be insulated.

The level of floor insulation that is desirable for floors is: R 1.0.

Guidelines

- Wall, floor and roofing materials have varying inherent insulating properties, which can be enhanced by the installation of additional insulation in ceilings, roofs and walls and floors to the recommended added R Value for the particular location, as per AS 2027.
- Lapped and taped sarking to the underside of tiled roof areas. Sarking can help to reduce heat gain from the sun reducing levels of insulation required.
- Prevent heat leakage by installing window and door seals.
- Window and door openings should incorporate pelmets and close fitting curtains falling to the floor. This seals an air gap behind the curtain, which acts as an insulating blanket over the wall opening.
- Take care to overlap and securely tape the ends of any insulating material during construction. Tape any tears or holes.
- Double-glazing should be considered for large areas of south facing glazing, as this is an area of direct heat loss in winter.
- Place insulation closet to heat source. For certain wall constructions and in all roof space, there needs to be two layers of insulation - one closet to the interior (for winter) and one closet to the exterior (for summer).

Quality Lifestyle Advantages

- Installing the recommended levels of insulation will add to the initial capital cost of the buildings, but will pay it self back many times over in reduced heating bills.
- Insulation will make the buildings warmer in winter and cooler in summer.
- Reduced energy use from heating will reduce greenbuildings gas emissions.

3.6 VENTILATION

Principles

- Cross Ventilation

Natural ventilation can be used to reduce interior temperatures and cool the people inside. It is important to remember that this strategy is successful only when the incoming air is cooler than the air inside.

Windows can be placed and sized to get the most desirable and efficient air flow through the building.

- Smaller windows low down on the windward side and larger windows on the opposite side of the room help increase the air pressure and air speed in the room.
- Rooms could be angled to face the breeze or angled no less than 45 degrees to the breeze. If this is not possible, a fence or a row of trees can be used to deflect the breeze into a room.

It is important to note however, that these strategies must be considered in conjunction with other recommendations for window sizes and orientation.

Air Circulation

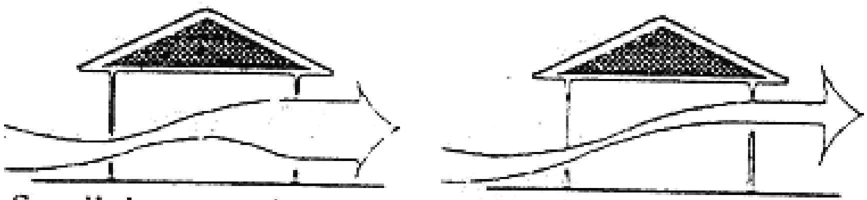
When the outside air is hotter than the temperature inside the buildings, cross ventilation will not reduce the internal temperature. On these days ceiling fans can be used effectively to make the occupants comfortable.

Vents

Hot air naturally rises and therefore vents can be located at ceiling level where the warm air can be removed and be replaced by cool air at the base of the buildings. To make this system more effective, a mechanical exhaust fan has the advantage of personal control. Care must be taken to cover the outlet in the cooler periods.

Assisted Ventilation

Ceiling fans are economical to operate and provide air movement across a broad range. Generally the blades move slowly, creating gentle air movement. The fan can effectively mix the air in the space and bring it all in contact with the structural mass that was cooled the night before.



Small, low opening on the windward side and large high openings on the down-wind side for good cross-ventilation.

Figure 4 - Cross Ventilation

Guidelines

Methods for controlling ventilation include;

- Taking advantage of prevailing winds by strategic location of openings and landscaping
- Mechanical or assisted ventilation

Favourable prevailing winds in Lake Macquarie are:

- North - easterly sea breezes in summer (depending on coastal proximity)
- Southerly breezes in summer

Summer westerlies are probably the most difficult winds to deal with due to their hot, dry quality and sheer ability to permeate. It is at these times and during severe cold conditions that air locks to entry doors are useful in maintaining a consistent level of comfort within.

However it can be said that the cost - effectiveness of providing special air - locks may not be justified because of the frequency of days when these conditions occur. Nevertheless, innovative planning may allow rooms such as laundries to incidentally become air-locks.

The orientation of an opening can deviate by up to 60 degrees from the wind direction without reducing ventilation efficiency.

Air speed is the cooling component of ventilation and it is important to know how to achieve the most effective cross ventilation for comfort. Maximum air speed is achieved by having upwind openings open to about 50% of the area of downwind openings.

Position windows and doors to allow prevailing breeze paths through the buildings in summer.

Windows should be aligned in a reasonably straight line - wind does not travel around corners.

Casement windows (side opening) can be used to help direct cooling breezes for ventilation.

Use grassed areas, pools, etc. to cool hot summer breezes before they enter the buildings. (ie. pool to the north or north-east)

Ceiling fans may be used to assist with cooling in summer, and can be used in winter to direct warm air back down into the room to reduce heating requirements.

Air conditioning should not be required in a well designed energy efficient building.

3.7 SOLAR ACCESS

Principles

All buildings should be designed for solar access by ensuring that:

- Windows of occupied spaces, and those of the adjacent buildings, and
- The major part of the enclosed private open space of both the neighbouring buildings and the subject building, are capable of receiving four hours of sunshine between 9am and 3pm on the 21st June.

Solar access can be described as:

1. allowing direct sunlight to penetrate the building;
2. providing a solar collector with direct sunlight;
3. fall of sunlight upon a private open space.

The retention of Solar Access is critical to the success of passive solar design.

New building development should optimise solar access and not unreasonably overshadow adjoining properties.

The 21st June is the most critical time to assess solar access. On this date the sun's altitude of 33 degrees at noon will cause shadows twice as long as an object is high. Council may require shadow diagrams to be submitted to ascertain the extent of overshadowing. The diagrams shall be prepared for the times of 9.00am, 11.00am, 1.00pm and 3.00pm on 21st June.

During mid-summer (the summer solstice), the sun rises from a point 28 degrees to the south of due east, and sets at a point 28 degrees south of due west. Its maximum altitude at noon is about 80 degrees.

During mid-winter (the winter solstice), in Lake Macquarie the sun rises at a point 28 degrees to the north of due east, and sets at a point 28 degrees north of due west. Its maximum altitude at noon is about 33 (see http://www.ga.gov.au/geodesy/astro/smpos.jsp) degrees to the horizontal, which is the same as a slope of about 1 to 2.

Guidelines

- Ensure solar access is maximised, and achieved to a building's occupied areas and staff open space, for a minimum period of four hours between 9.00am and 3.00pm, during the winter solstice.
- Where solar access to the living areas of adjacent dwellings already exists, ensure that new development maintains this four hour minimum standard.
- Solar access to solar water heaters is required throughout the day.

3.8 SOLAR CONTROL

Principles

Most of the solar energy gained by buildings in summer, enters through unshaded or poorly shaded windows, glass doors, skylights and other glazed apertures. This heat cannot return through the glass and thus rooms become hotter and hotter, i.e. the glass buildings effect.

Shading devices can be both internal and external. Internal devices such as heavy drapes, venetian and holland blinds can be effective depending on design and colouring. However, it is best if the sunlight is prevented from reaching the glazing.

The choice of external shading devices is dependent on the orientation of the particular window to be protected. Those windows facing north can be protected by an eaves overhang while those to the east and west will require more than eaves.

Guidelines

Types of exterior shading devices:

- eaves
- awnings
- overhangs
- pergolas
- trees

Glass lets heat in about three times faster than an uninsulated brick veneer wall.

Glazing facing east or west should be shaded as much as possible.

The width of eaves is dependent on the depth of the glazing to be protected.

Eaves Design - eaves on the north facing walls should completely shade glazing from October to February. Extending the eaves so that they shade glazing at other times will reduce the amount of autumn and spring sunshine entering the buildings. If during these seasons the amount of heat entering the buildings is at times too great, white or silver backed internal shading devices can be used.

Pergolas - with deciduous vines, slats or louvres are an excellent form of shading, particularly if the louvres are adjustable.

Deciduous trees can be effective if fully shading windows.

3.9 WINDOWS

Principles

Windows

Windows provide view, natural light, ventilation and heat into and out of the building. They can be used to allow the sun to heat up the buildings in winter, but must be covered with curtains to retain the heat at night. In summer, windows can be opened to allow breezes to cool the buildings, but it is important to stop the hot summer sun entering the buildings through the windows.

Greenhouse Effect

Windows let the sun’s short wave radiation through to the inside of the buildings, floors and wall finishes in the room. These in turn radiate heat in the form of long wave radiation. This long wave radiation cannot pass through the glass and so the room remains warm.

This phenomenon, known as the greenhouse effect, can be put to use to heat up a buildings in winter, and so reduce the amount of conventional heating required. The windows must be correctly sized and orientated for this to work effectively.

Heat Loss Through Windows

Once the inside of buildings have been warmed by the sun during the day, it is important not to let the heat escape at night. Uncovered conventional windows can be one of the most critical areas of heat loss at night. Heat is not only conducted through the glass, but also through the framing material. The use of double glazing or close-fitting heavy curtains with pelmets and insulating frames can reduce heat loss through windows.

Shading Windows

The glass buildings effect will heat the buildings in summer, if the sun is allowed to enter the building. Properly located shading can prevent this, while still enabling the buildings to receive winter sun. Windows on the north, west and east must be shaded in summer. This can be done by using eaves and other external shading devices, curtains or vegetation.

3.10 DRAUGHTS

Principles

Energy Efficiencies

While some ventilation is essential for good health and the prevention of condensation, too much of it can cause discomfort and waste energy.

Heat Loss

In winter air leaks may account for 12% to 25% of heat losses in buildings with an insulated roof.

Construction

Draughts may cause discomfort by creating localised chilling, draughts result from air flow through the smallest openings, gaps around doors and windows, vents, flues, and chimneys. Construction joints may also leave many gaps at edges of floor and ceiling joints and around pipes and ducts.

Position

If a building is in a exposed position there is a greater potential for draughts to occur.

Guidelines

Reducing Drafts

Warm air can be lost from a buildings through any gaps, cracks or vents. These often occur around windows and doors, up chimneys, in areas where water or duct pipes may penetrate, and at junctions between walls and skirting, walls and floorboards etc. Preventing draughts can be easily done. Some suggestions are to:

- Use a damper for chimneys.
- Use draught excluders, weather seals or caulking compounds to fill any gaps.
- Only use ventilation fans for as long as necessary.
- Keep doors and windows closed.
- Position entrances away from cold winter winds or use an air-lock on entrances.

Protect door openings by recessing the entrance or provide enclosed porches in particular on south and west side openings.

Use weather-strips around doors and windows and draught excluders on doors.

Seal gaps in construction with weather resistant products.

Ceiling exhaust fans should be fitted with automatic shutters or fit a hinged lid. Exhaust fans should be vented to outside to prevent condensation problems in the roof space which may damage timber and ceiling linings.

Fireplaces should be capable of being sealed with a damper or close fitting panel across the front of the fireplace when not in use.

Minimum Ventilation

Some winter ventilation is needed to stop condensation which builds up in a buildings. It also allows toxins and gases which accumulate inside buildings to escape.

Quality Lifestyle Advantages

- Reduced heating bills by reduced draughts into the building.
- The occupants will have cooler summers and warmer winters.
- Cool breezes will move through the building and hot air will be extracted ensuring summer comfort.
- Reduced energy use from heating will reduce green buildings gas emissions.

3.11 COLOUR

Principles

The colour choice of materials and rooms does effect the energy efficiency of your building. Colours which are light and cool will reflect the summer sun away from the buildings while keeping it brighter inside during dark winter days. As a rule, light colours reflect heat while dark colours absorb heat. Summer is the season to be concerned about when using dark colours, as the amount of heat gained in summer is significantly greater than that in winter.

External Glare

Glare through windows is often caused by light coloured paved surfaces on the ground outside the windows. Dark surfaces outside will absorb the heat from the sun but can be uncomfortably hot to walk on in summer conditions and will also radiate heat back into the buildings or windows. Landscaping such as lawns or plants are much better outside north windows than paving.

Roof and Wall Colour

The roof should be light in colour: very light pastels, light grey or light brown are all acceptable. Dark colours may help in winter situations but will cause overheating in summer. Black will absorb the most heat. If dark tiles are to be used they need to be lined with reflective aluminium sarking. The walls should be light as well, this helps to reflect heat away from your buildings.

Shading Devices

Shading devices protect windows from the sun's heat. Lighter colours are preferable for shading as they reflect the heat away, rather than absorb it. Colours suitable are very light pastels, white, beige, and light grey. Curtains should be light coloured lining to reflect heat back out through the glass. Materials used should be fade proof.

Quality Lifestyle Advantages

- Reduced lighting bills through the use of lighter colours in and around the buildings.
- The buildings will be cooler in summer giving a reduction in air-conditioning costs, if used.
- Lighter colours mean a brighter buildings internally.
- Reduced energy use means a reduction in greenhouse gas emissions and if you use organic or low odour paints, you will reduce harmful fumes inside your buildings.

4 ENERGY EFFICIENT APPLIANCES

4.1 SOLAR HOT WATER HEATERS

Comparisons between energy sources –

The main energy sources generally available (electricity and natural gas) have different attributes including the production of greenhouse emissions. The table below illustrates the emission differentials between some fuel sources;

Table 1 - Greenhouse (CO_2) emissions from different fuels

FUEL	**EMISSIONS CO_2 (kg/GJ)**
Natural Gas	55
Petroleum	77
Black Coal	91.7
Electricity	286

Given the disparity between greenhouse emissions it is important that energy users choose the most efficient energy for a particular use.

Electric heat pumps or natural gas are most suited to water heating and space heating of dwellings while electricity is most suited to lighting and electrical appliances. Serious consideration should be given to achieving the optimum use of the various energy sources to minimise the production of greenhouse gases.

Guidelines

Hot water is one of the most expensive items of an average domestic energy bill and averages about 27% of the total.

By using solar water heaters or heat pumps savings of 60-75% can be achieved and a dramatic reduction in the consumption of gas or electricity.

The types of solar water heaters are:

Close Coupled Thermosiphon System

The collectors and storage tank are in one unit with the storage tank at a higher level than the collector plate.

Remote Thermosiphon System

The storage tank is located away from the collector, usually in the roof space.

Forced Circulation System

Water is circulated between the collector plate and the storage tank by means of a pump. The storage tank is usually at ground level.

The installation of solar water units requires care and regard should be given to ensuring;

- The structure will support the collectors and storage tanks;
- The collectors are inclined between 14° and 45°;
- The collector plates face true north;
- The collector plates will not be shaded by other
- buildings or mature trees;

- Access provided for maintenance and removal;
- Roof space storage tanks to have an overflow collection tray and drain;
- The units are positioned so as to reduce visual impact to street and adjacent properties;
- The unit colour to be complimentary with roof colour
- Heat Pump - an alternative water heating system

A hot water heat pump uses the same principle as a refrigerator but in reverse. Evaporator plates extract heat from the air during the day and night. The system is electrically powered but uses only 30% of the electricity used by a conventional hot water heater.

Compared to other forms of water heating significant savings can be achieved by using hot water heat pumps and such a system will assist in the reduction of greenhouse gas emissions.

Solar water heaters/heat pumps - "payback period"

A solar hot water system is more expensive to buy and install than a conventional system but will save money over time through reduced running costs. Lake Macquarie, savings up to 70% of the hot water heating bill is achievable using such Greenhouse friendly appliances.

The amount of time it takes to recoup the initial cost is known as the "payback period". This period will vary depending on the type of development, size of the system, the energy used and the energy price.

A typical payback period for a solar hot water heater/heat pump would be 8 years after which significant savings can be made on energy bills. A typical unit has a life expectancy of 15 years.

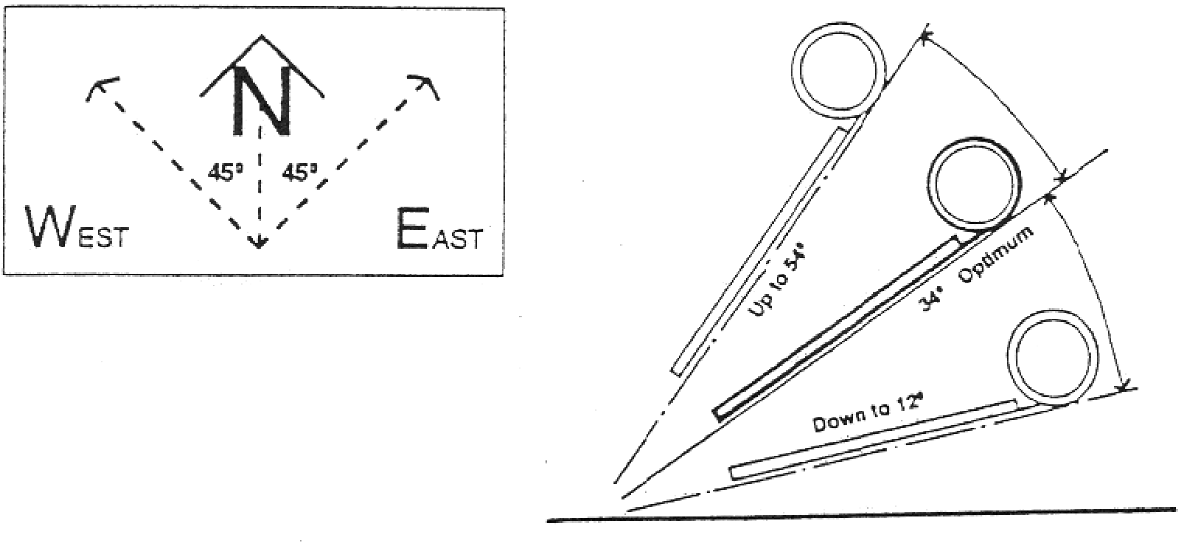


Figure 5 - Optimum range and elevation for solar collector.

Quality lifestyle advantages –

Installation of a gas or electric boosted solar or heat pump hot water system will result in significant long-term savings in energy bills.

4.2 SPACE HEATING AND COOLING

Principles

The aim of building energy conservation is to design a dwelling that will require little if any additional space heating and cooling.

If heating is required, there will be substantial savings on both capital and running costs as the heater can be much smaller and run for less time.

Generally, with energy efficient design, the number of days where additional cooling is required would not justify the cost of air-conditioning systems.

However, where ultimate comfort conditions are required, in choosing a form of space heating regard should be given to;

- The efficiency of the system.
- The generation of greenhouse gases.

Guidelines

Space Heating

The following information provides comparisons of the efficiencies of different heating systems:

Solid fuel heating

Depending on their design, open fires only produce heat at about 25% efficiency. However, this can be increased to up to 60% if designed with an air circulation system.

Stoves and heaters

Non airtight appliances operate at an efficiency of around 30%. An airtight version could operate at between 40-60% efficiency.

Oil Heaters

These fall into two categories, flued and flueless. Flued oil heaters have an efficiency of up to 75%. If a flueless oil heater is used, up to 95% efficiency is possible, but adequate room ventilation must be provided, which effectively lowers its overall efficiency.

Gas Heaters

Gas heaters operate at an efficiency level of approximately 75% for flued models. This rises to up to 95% to flueless models, which also require room ventilation.

Electric Heating

This is the most common source of space heating in New South Wales. Its efficiency of heating is often measured as 100%, but this refers only to the heating units itself. There are considerable energy inefficiencies in the generation and transmission of electricity. Overall efficiency at the point of end use is only up to 35% of the original energy available. The types of heater available are:

- radiators
- convection heaters
- fan heaters
- night storage (block heaters)
- under floor heating (electrical or water)

'Heat pump' - reverse cycle air conditioning

The heat pump provides a very efficient form of heating, that can provide both winter heating and summer cooling.

Guidelines

Aim to install an energy efficient space heating system in all new dwellings.

Space Cooling

Principles

Generally, in Lake Macquarie the number of days which are uncomfortably hot, do not justify the cost of installation and operation of air-conditioning (A/C) systems. A/C systems increase CO_2 emissions into the atmosphere.

In Lake Macquarie, passive methods of minimising heat gain are encouraged. A building should be designed with window shading, appropriate insulation, and sealed against hot air infiltration during the day. Cross ventilation and natural cooling during the evening is desirable. Ceiling fans can provide a high level comfort on most hot days, at a very low running cost.

If a space cooling system is to be used, consideration needs to be given to the size and location of rooms to be cooled, its location and environmental impact of the unit on adjacent dwellings.

Guidelines

- Avoid the installation of air conditioning systems.
- Identify breeze paths and install ceiling fans in all new dwellings.

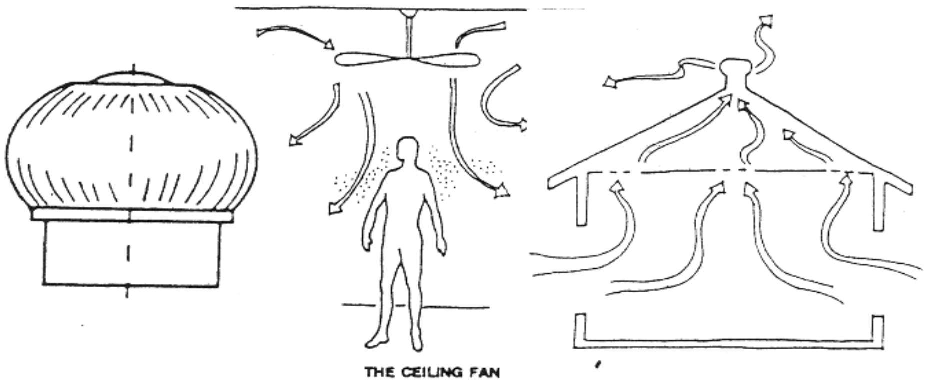


Figure 6 - Illustrating Space Cooling System.

5 ENERGY EFFICIENT DESIGN FOR COMMERCIAL BUILDINGS

Passive Solar Design

Whether buildings are being renovated or designed from scratch, simple architectural features which minimise air conditioning and lighting needs can be incorporated.

- Vertical louvres on east and west sides of building
- Planting provides shade around exposed walls and glazed surfaces
- Lift services and kitchens/toilets situated on east or west sides of building
- Insulated walls and roofing materials – R 3.3 if possible
- Ambient light controlled shading incorporated into window design on northern walls
- At a minimum, double glazed windows with low thermal conductivity frames

Metering and sub-metering

By installing meters on each energy source you can identify which areas are using excess energy and take steps to correct energy waste.

- Smart meters allow you to check the accuracy of your main account meter
- Place meters on each mechanical and electrical switchboard and know where your energy is being used.
- Power factor correction will make the energy supply more efficient
- Accurate metering results in accurate tenant billing
- Use Energy Star enabled office equipment

Energy Efficient Lifts

By installing latest technology lifts you can reduce energy use by as much as 30% and eliminate the need for a lift motor room.

- Control the lifts with either the Building Management System (BMS) or a dedicated Programmable Logic Controller (PLC) that “learns” lift utilisation
- Replace electromechanical contacts with integrated circuit (IC) controllers
- Ensure that lift lobbies are on lighting control circuits

Building Management System

A BMS is a computerised central control system for managing operating systems within your building. By providing tighter control a BMS means big cost savings.

- A BMS should allow for equipment from different suppliers to be incorporated into the central control systems.
- It should cover air conditioning, ventilation and heating, lift services, domestic hot water and lighting.
- Robust reliable sensors allow optimal accuracy for your operating system.
- Large good quality monitors give operators tighter control
- Windows-based lighting and air handler software allows access by non-engineers

Air Conditioning

The air conditioning system determines the quality of the internal environment of your building and is a major energy consumer.

- Outside –air economy cycles allow for free cooling in winter and spring and night purging of hot air in summer – controlled by a combination of temperature sensors and heat content controls.
- Gas absorption or gas engine chillers produce low greenhouse emissions and can also produce hot water for use in heating or hot water services.
- High-efficiency pumps and motors reduce energy consumption and cost little more than less efficient motors.
- Variable speed drives on selected motors such as cooling towers or primary and secondary circuit pumps, cut energy consumption by 50% with only 12% reduction in flow of water or air.
- An air-to-air heat exchanger cools hot air coming into the building with outgoing cool air instead of throwing it away -–and does the reverse in winter.
- Air circulation through the centre of double glazed windows eliminates the need for perimeter heating/cooling.
- Ducted return air with an exhaust fan system provides a positive airflow.
- Variable Air Volume air handlers give finer environmental control and when linked to dual mode (temperature/CO2) thermostats produce occupancy linked ventilation.

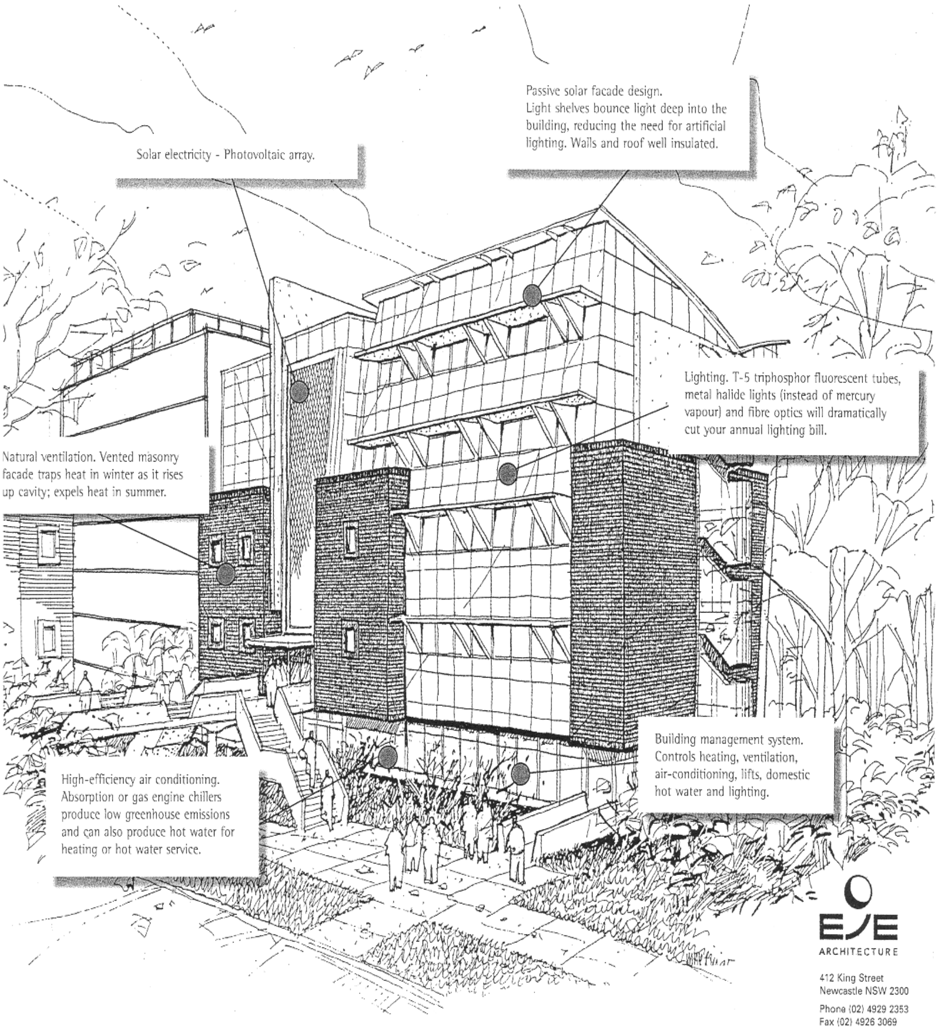


Figure 7 - Key Components of an energy efficient commercial building

Lighting

Lighting contributes to the ambience and appearance of your building but can be an unnecessary drain on your pocket.

- Installing T-5 triphosphor fluorescent tubes, metal halide lights (instead of mercury vapour) and fibre optics will dramatically cut your annual lighting bill while providing the correct light output.
- Using silverlux reflectors will provide the same lighting level with only half as many light tubes.
- Steer away from low voltage downlights except where needed for aesthetic reasons: then use infra-red corrected downlights with IC transformers
- Control and dimming of lighting is essential to optimising energy use. Utilise photoelectric perimeter dimming and motion sensors in individual luminaries.
- Lighting zone systems allow specific areas to be lit without turning on all the lights
- Occupancy sensors can save you money by cutting power use when it is not needed.

Car park ventilation

When carpark ventilation runs 24 hours a day it can represent up to 20% of your operating costs.

- Use natural ventilation if possible.
- By monitoring carbon monoxide levels you can vary the ventilation system at times of low car park use with variable speed drive fans.
- Enlist the BMS to switch off the ventilation system after hours.

Hot water

There are several ways you can cut down on the significant amounts of energy and water used to provide hot water in a commercial building.

- Install solar panels and enjoy solar hot water with gas boost or solar heat pump
- A gas-driven chiller for air conditioning can provide heat for your hot water needs
- Instantaneous gas hot water units are 30% more energy efficient than normal storage units
- Water pressure restricters in kitchens, showers and toilets reduce the amount of energy needed to heat water.
- Amenities blocks can utilise motion sensors to activate urinals and exhaust fans.

5.1 NABER AND GREEN STAR

NABERS is a rating tool for buildings that are in operation.

Green Star is an building energy efficiency tool for the design and as built stages.

Council's DCP requires that commercial and industrial building over 4000m2 GFA demonstrate they achieve a minimum 4 star Green Star rating. Formal accreditation is not required but a demonstration that a building achieves this minimum star rating using the Green Building Council's online assessment tool is required. See www.gbca.org.au

6 LIST OF PLANTATION AND REGROWTH TIMBERS

Recommended Plantation Timbers

Lake Macquarie City Council recommends the use of the following plantation timbers. These are mainly pine species, often referred to as softwoods:

Caribbean Pine – (Pinus caribaea) from Queensland and New south Wales.

Hemlock – (Tsuga heterophylla) from North America.

Hoop Pine – (Araucaria cunninghamii) from Queensland and New South Wales.

Oregon – (Pseudotsuga menzieslii) from North America and New Zealand.

Radiata Pine – (Pinus radiata) from Australia, New Zealand, Fiji and Chile.

Slash Pine – Pinus elliottii) from Queensland, New South Wales and New Zealand

Poplar – (Poplulus sp.)

Recommended Australian Regrowth Timbers

Lake Macquarie City Council recommends the use of regrowth native timbers, often referred to as 'hardwoods' including:

Blackbutt - (Eucalyptus pilularis)

Spotted Gum - (Eucalyptus maculata)

Cypress Pine - (Callitris sp)

Sydney Blue Gum - (Eucalyptus saligna)

Flooded Gum - (Eucalyptus grandis)

Manna Gum - (Eucalyptus viminalis)

Jarrah - (Eucalyptus marginata)

Silvertop/Stringybark - (Eucalyptus laevopiniea)

Red Ironbark - (Eucalyptus sideroylon)

Recycled Timbers

Lake Macquarie City Council recommends the use of recycled timbers.

Lake Macquarie City Council **recommends the use of the following sustainable timbers** as alternatives to rainforest and old growth forests:

For framing and general construction

- Radiata Pine (F5 & F7)
- Laminated Veneer Lumber (LVL)
- Plantation Grown Oregon
- Cypress Pine
- Australian regrowth timbers eg. Blackbutt, Red Ironbark
- Composite timber products eg. glue laminated beams
- Recycled timber

Concrete Formwork

A large percentage of formply used in Australia is made from tropical timber. Use only formply made from plantation pine - Radiata, Slash and Hoop Pine. Reuse formply whenever possible and do not specify a higher grade than what is required.

Inground Uses

- Recycled Australian timbers
- Australian regrowth timbers
- CCA treated radiata Pine (pressure impregnated)

Cladding

- Treated plantation pine
- Australian regrowth timber
- Treated Exterior grade plywood
- Durable recycled timber

Imported Rainforest Timbers - to be avoided

Most rainforest timber imported into Australia comes from Indonesia, Malaysia, Burma, Papua New Guinea and the Philippines. All timber cut in these countries is cut from virgin Rainforests. There are no plantations yet old enough to provide timber logs.

THE USE OF THE FOLLOWING IMPORTED RAINFOREST TIMBERS IS NOT RECOMMENDED

Timber merchants often group all rainforest timbers using two names - **Maple or Meranti**.

More specifically these timbers are:

Agathis	Gaharu Buaja	Mahogany	New Guinea Walnut
Alan	Gmelina	Mangasinoro	Nyatoah
Almon	Ipil	Marfim	QBA Saluk
Amboyna Wood	Iroko	Mayapis	Pacific Maple
Apitong	Jelutong	Mavota	Padauk
Balau	Kalantas	Melawis	Palaquim
Balsa	Kapur	Mengkulang	Pink Satinwood
Bangtikan	Keladin	Meranti	Ramin Red Lauan
Batu	Kempas	Merawan	Rosewood
Baygo	Keruing	Merbau	Selangan Kacha
Betis	Ketiau	Mersawa	Seraya
Bomeo	Camperwood	Koto	Motoa
Calantas	Lauan	Narra	Tanquile
Camphorwoo d	Lanutan	New Guinea Beech	Teak
			Vesi

7 LIST OF TREES AND SHRUBS OF LAKE MACQUARIE

BOTANICAL NAME	COMMON NAME
Acacia longifolia	Sydney golden wattle
Acacia myrtifolia	Myrtle wattle
Acacia smithii	Lilly Pilly
Angophora costata	Smooth-barked apple
Angophora floribunda	Rough-barked apple
Banksia collina	Honeysuckle banksia
Banksia integrifolia	Coast banksia
Banksia serratifolia	Saw-tooth banksia
Casuarina glauca	Swamp oak
Casuarina littoralis	Black sheoak
Correa alba	White correa
Correa reflexa	Common correa
Doryanthes excelsa	Gymia lilly
Eucalyptus botryoides	Bangaly
Eucalyptus gummifera	Red bloodwood
Eucalyptus haemastoma	Scribbly gum
Eucalyptus maculata	Spotted gum
Eucalyptus punctata	Grey gum
Eucalyptus robusta	Swamp mahogany
Hakea teretifolia	Needlebush
Lambertia formosa	Mountain devil
Leptospermum flavescens	Yellow tea-tree Leptospermum juniperinum
Prickly tea-tree	
Leptospermum laevigatum	Coast tea-tree
Livistonia australis	Cabbage-tree palm
Leucopogon parviflorus	White beard
Melaleuca ericifolia	Swamp paperbark
Melaleuca quinquenervia	Broad leaved paperbark
Melaleuca sqarrosa	Scented paperbark
Myoporum accuminatum	Boobialla
Syncarpia glomulifera	Turpentine
Xanthorrhoea australis	Australian grass tree

Floral Emblem

Lake Macquarie City Council has adopted the bottlebrush (callistemom spp) as the flora emblem of the city. Bottlebrush come in a wide variety of sizes and flower colours. They attract birds and are spectacular in spring.

The above species list is not exhaustive or restrictive. There are other species which may be appropriate to the area as well. It is recommended that expert advice be obtained from a landscape designer, horticulturist or your local nursery.

8 REFERENCES

Commonwealth Dept. of Housing and Regional Development - AMCORD

Building Better Cities - Newcastle Housing Design Manual

Building Energy Conservation - Council of Camden - DCP No 94

Department of Urban Affairs and Planning - NSW Model Code.

Department of Primary Industries & Energy. Site Planning in Australia - Strategies for energy efficient residential planning

Leichhardt Council - Energy Efficient Housing - - DCP No 17

Solarch for Armidale City Council - Energy Efficient Housing for Armidale and New England

Sustainable Energy Development Authority - Energy Smart Buildings Policy

Sustainable Energy Development Authority – Building of the Future

Sustainable Energy Development Authority – Rating the Greenbuildings Performance of Commercial Buildings

Sustainable Energy Development Authority – Building Greenbuildings Rating Commitment Agreement (new buildings and refurbishments)

Sustainable Energy Development Authority – Building Greenbuildings Rating Commitment Agreement (new tenancies, fitouts or refurbishments)

Sustainable Energy Development Authority – Guidelines for the use of Simulation in Commitment Agreements

Sustainable Energy Development Authority – Guidelines for Developing an Energy Management Plan