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Ecologically Sustainable Design Report

1006290 Westfield Parramatta

Prepared for:

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The success and realisation of the proposed initiatives will be dependent upon the commitment of the design team, the development of the initiatives through the life of the design and also the implementation into the operation of the building. Without this undertaking the proposed targets may not be achieved.

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Executive Summary

This report outlines the key Ecologically Sustainable Design (ESD) initiatives for the proposed mixed commercial and retail development bound by O'Connell, Argyle, Church and Campbell Streets in Parramatta.

During this early stage of the project design, a series of sustainability initiatives have been developed in order for the project team to set a clear sustainability strategy for the project and allow for complete analysis of the options to be considered. During concept design development, each design option will be considered in terms of total life-cycle impact, including embodied energy and water, value of material resources and likely future trends. The design will be evaluated at key project stages to ensure that the best outcome is achieved in terms of total carbon and environmental impacts.

The development is being designed to exceed minimum requirements in terms of Ecologically Sustainable Design (ESD), and is aiming to achieve the following green building ratings:

- 4 star Green Star - Retail (v1) rating (formal certification not targeted, design intent only);
- 5 star Green Star –Office (v3) rating;
- 3.5 star NABERS Energy retail rating (formal certification not targeted, design intent only); and
- 4.5 star NABERS Energy office base building rating (formal certification not targeted, design intent only).

Key strategies that will be considered cover a broad range of environmental performance criteria throughout the design, construction and operational phases of the building, as follows:

Design Phase	
Built Form	• Analysis and understanding of solar heat loads within the building to optimise the facade, reducing energy consumption whilst maximising the benefits of natural daylight and external views • Optimised built form and facade to minimise embodied energy into the development • Optimised built form to maximise indoor environment quality
Mechanical Design	• Selection and design of efficient air conditioning plant • Implementation of variable operation components to control the building efficiently and high and low loads • Enhanced controls to automatically control plant and equipment for optimum efficiency • Consideration to additional systems and capacity to enhance indoor environment quality. Ventilation rates will be increased above the minimum requirements to improve indoor air quality of the occupied building. The mechanical system is designed to provide good air change effectiveness throughout the entire floor plates

Design Phase	
Electrical Design	• Selection and design of lighting systems which provide high light levels with low energy consumption • Enhanced controls to automatically control plant and equipment for optimum efficiency including zonal switching and daylight dimming • Design of electrical systems to enable monitoring of energy consumption, water consumption waste generation in association with building plant and equipment. Implementation of automatic energy and water waste detection to reduce wastage • Consideration of systems that enhance indoor environment quality including appropriate lighting levels and reduction of lighting flicker associated with fluorescent lighting • Consideration to low carbon electricity sources such as photovoltaics
Hydraulic Design	• Selection and design of systems with a low potable water consumption requirement • Design of rainwater capture systems for reuse within the building, reducing potable water demand • Stormwater capture and detention to minimise the peak storm water flows from the site
Transport	• Promotion of alternative forms of transportation including cyclist facilities, public transport and low emission vehicles

Construction Phase	
Commissioning	• Detailed commissioning of the buildings mechanical, electrical and hydraulic system to ensure efficient operation • A 12 month building tuning process to optimise the systems through differing weather events and occupancy rates
Construction Practices	• A comprehensive environmental management plan will be implemented to minimise the impact on the immediate environment • 80% of construction waste will be either reused or recycled • Construction energy and water consumption will be monitored to minimised wastage
Materials Selection	• Materials installed in the building during construction will be low in volatile organic compounds and low in formaldehyde emissions to improve the indoor air quality of the finished building • Preference to recycled building materials will be used in the construction process and where recycled building materials are not available, materials low in embodied energy will be selected • Steel will be selected to have a high recycled content • Portland cement will be replaced with recycled content and aggregate will be made from waste product • PVC use will be reduced by 20% and where it is used it will be sourced from companies who follow the 'Best Practice Guidelines for PVC in the Built Environment'

Operational Phase	
Knowledge Transfer	• A detail transfer of knowledge from the construction team to the buildings operational team to ensure all sustainable design initiative are fully coordinated into the operation • After project handover all building systems will be continuously tuned and monitored to ensure efficient operation • A building users guide will be provided to the building operator and the occupants to explain the correct management of the building
Ongoing Management	• The energy, water and waste monitoring system will be monitored on a monthly basis to identify and rectify areas of wastage and to drive continual improvement • A NABERS Energy and Water rating of 4.5 stars for the office and 3.5 stars for the retail extension will be achieved on a monthly basis.
Fitout and Refit Considerations	• A detailed guide to tenancy fitout and re-fit will be developed to provide information to tenants to minimise their environmental impact and ensure appropriate integration. This guide will include: ○ Lighting types and maximum power allowances ○ General equipment maximum power allowances ○ Requirements for lighting and equipment controls ○ Materials usage guidelines for reduced embodied energy ○ Waste reduction techniques and requirements

The design response to sustainability is explained in more detail in the following sections.

1 Introduction

This report outlines the key Ecologically Sustainable Design (ESD) initiatives for the proposed development bound by O'Connell, Argyle, Church and Campbell Streets in Parramatta, which is committed to a high level of environmental performance. The scope and systems described within this report cater for these performance requirements, and will be further developed through the detailed design stage.

The development is being designed to exceed minimum requirements in terms of Ecologically Sustainable Design (ESD), and is aiming to achieve the following green building ratings:

- 4 star Green Star - Retail (v1) rating (formal certification not targeted, design intent only);
- 5 star Green Star –Office (v3) rating;
- 3.5 star NABERS Energy retail rating (formal certification not targeted, design intent only); and
- 4.5 star NABERS Energy office base building rating (formal certification not targeted, design intent only).

The project is also required to comply with the Building Code of Australia Section J for Energy Efficiency. These commitments are outlined in more detail in the following sections.

This report has been developed in three key sections as noted below. Each section will focus on a key concern for the development and provide an insight as to how these items will be addressed throughout the design process.

- Resource Consumption - this section of the report provides information into the methodologies to be investigated to ensure that energy, water and materials consumption is minimised throughout construction, operation and demolition.
- Creating Spaces for People - this section of the report outlines how the internal spaces will be optimised for occupant health, well being and comfort.
- Codes and Ratings - an outline of how the building will comply with relevant voluntary and mandatory codes and rating schemes will be outlined.

2 Resource Consumption

Buildings consume considerable natural resources in their construction, operation and demolition. This section of the report will provide details as to the potential impacts caused by the building and how these impacts have been reduced when compared to typical buildings of this nature. The building will aim to reduce the total embodied energy and carbon considered in the construction and then aim to maximise the operational efficiency of the buildings services to provide and enhance tenant provisions for the minimum amount of energy and water. Furthermore, methods for maintaining operational efficiency over the life of the building will be investigated to ensure that the benefits are maximised over the life of the building.

2.1 Energy Reduction Strategies

A substantial part of Australia's employment and economic activity is centred on construction and occupation of commercial buildings such as offices, shops and restaurants. As can be ascertained from the chart below commercial buildings are responsible for approximately eight and a half million tonnes of carbon dioxide per annum and the total retail sector emissions is approximately nine million tonnes of carbon dioxide per annum. These emissions continue to rise as the demand for commercial and retail space increase.

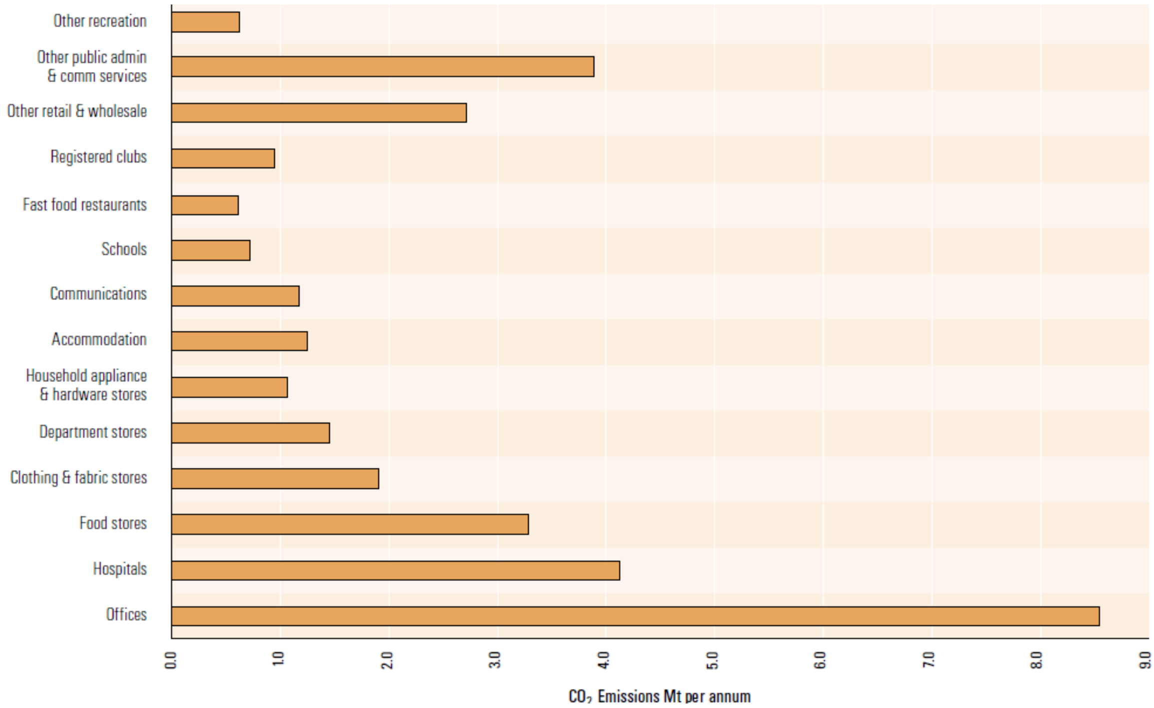


Figure 1: Greenhouse gas emissions by building type

(Source: Australian Commercial Building Sector Greenhouse Gas Emissions 1990-2012)

Improving the energy efficiency of commercial buildings has the potential to deliver savings on energy bills and building maintenance costs, happier and more productive workers and increased building value.

This section sets out possible strategies to reduce the buildings energy demand and greenhouse gas emissions.

2.1.1 Air Conditioning Systems

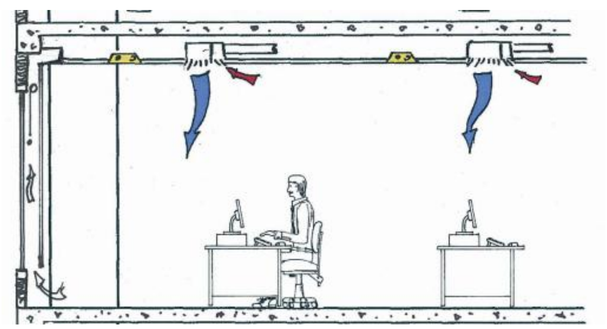
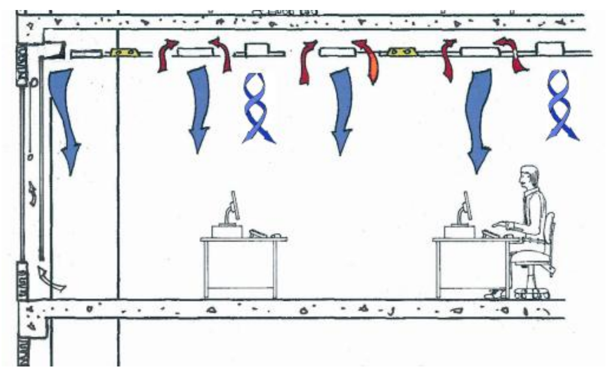
The proposed building air conditioning system in the retail extension is likely to consist of an efficient constant air volume system zoned independently between the mall and tenancies for optimum efficiency.

To enhance the system options to remove the air conditioning to the mall zones will be investigated. To maintain comfort conditions in the mall spill air from the tenancies will provide a level of conditioning to the mall. This will reduce the energy requirements of the chilled water system and the air handling system. The system will also incorporate CO_2 monitoring and control to modulate the amount of outside air based on the number of people in the space.

The system will also be enhanced by the use of an economy cycle. An economy cycle will utilise high levels of outside air when the ambient conditions are favourable rather than conditioning the air. This strategy will reduce the annual heating and cooling loads in the Sydney region by up to 40%, saving significant energy and carbon emissions.

Each air handling unit shall be provided with chilled and hot water from a central system. The chiller plant room may be located within the roof level plant room, and the central hot water and heat rejection plant to be located at roof level.

The proposed building air conditioning system in the commercial tower will be generally one of three options. Each option has inherent environmental benefits as noted below.

	**Variable Air Volume System:** A VAV system provides conditioned air through overhead supply ducts. The quantity of air is modulated to maintain comfort conditions in the space. The primary benefit of a system of this type is the simplicity of the system whereby comfort is maintained in many zones which are operating differently. The system can be enhanced with energy saving features such as economy cycle, carbon monoxide control and optimum start.
	**Chilled Beam System:** A chilled beam system utilises chilled water running through radiators to provide cooling to the space. Fresh air is provided through separate air diffusers. The primary benefit of a system of this type is that large quantities of air does not need to be transported through the building, relying on small quantities of chilled water being transported instead.

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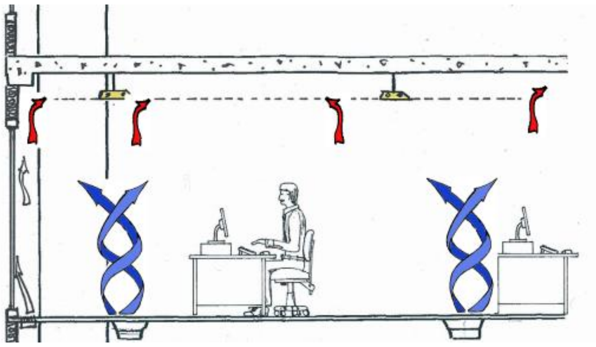
<tr>
<td></td>
<td>Underfloor Air Distribution System:

Underfloor air distribution acts similar to a VAV system however the air is distributed through floor mounted diffusers. The air is distributed at a higher temperature to maintain occupant comfort.

There are several primary benefits of an under floor system. The system provides a higher indoor environment quality as the air bourn containments are removed from the space without being re-distributed. Additionally the lighting loads in the building do not need to be conditioned as they are outside of the occupied zone and the air supply temperature is higher, requiring less energy to cool the air.</td>
</tr>
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2.1.2 Lighting Systems

The lighting systems will provide adequate illumination to allow building users to function whilst minimising the energy consumption. The retail areas of the redevelopment will utilise high efficiency LEDs where possible and efficient fluorescent lighting. The buildings commercial areas and car parks will be lit by high efficiency T5 fluorescent lamps whilst all back of house spaces will be lit by LED luminaires.

In association with the efficient lighting sophisticated controls will be installed to ensure that minimal energy is wasted, these controls may included:

- Time clocks with occupancy sensors to commercial building areas;
- Daylight sensors to space adjacent to glazing or under skylights;
- Small lighting zones to ensure that the controls benefits are maximised;
- Occupancy sensors which default to off for all back of house spaces; and
- Occupancy zoning functions to car park lighting.

2.1.3 Vertical Transportation

Vertical transportation within the building will be split to service the high rise and low rise sections of the building separately, this will provide enhanced trip time reductions and will increase the efficiency of the vertical transportation systems. In addition to the inherent benefits of the lift planning and design it is possible that the following technologies will be incorporated to reduce the energy consumption of the vertical transportation systems:

- Regeneration - utilising the potential energy stored in the system. When the lift is in free-fall or free-rise, depending on the balance of occupants and the counter weights, the regenerative drive can convert this energy into electricity rather than dissipating as heat.
- Dispatch control - Implementation of destination controls to optimise the pattern of passenger pick-ups and drop-offs. The system aims to reduce the number of stops and the distance travelled, therefore saving energy.
- The standby energy consumption will be reduced by incorporating energy efficient lighting and smart controls to switch equipment off when the lift is not in use.

- VVVF - Variable voltage, variable frequency drive enable consistent control with reduced currents, high power factors and increased energy efficiency.

2.1.4 Ancillary Systems

All ancillary systems in the development will be controlled via smart controls to either switch-off or reduce the impact of ancillary lighting, pumping and ventilations systems. The controls will be based on demand (such as carbon monoxide in the car park) or occupancy (such as plant room lighting).

2.1.5 Commercial Tower and Retail Integration

The retail and commercial building components of the development may be integrated into the smae common building systems. The use of the larger commercial systems will ensure that the efficiency of the building always remains high and can capitalise on the centralised services and systems.

2.1.6 Low Carbon Energy Systems

The development will be investigating the implementation of a low carbon energy generation system to reduce the developments carbon emissions. In each case the development will also investigate the provision of the low carbon energy to the tenant of the building to aid the overall carbon impact. As new technologies are being developed continuously it is not possible to commit to a single technology at this stage, however the development will investigate all options. The main systems to be investigated for a full life cycle review and cost analysis to determine the most appropriate solution are detailed below.

Trigeneration/Fuels Cells

A trigeneration system utilises low carbon intensity natural gas burnt in an engine. The engine will produce electricity and waste heat. The waste heat is utilised to heat water for domestic water heating or HVAC heating purposes or can be used as energy input into an absorption chiller to create chilled water for the air conditioning system.

As an alternative to a gas engine the potential to install a fuel cell will be investigated. A fuel cell provides a similar function to the gas engine however as a chemical process drives the system the efficiencies can be higher and the emissions of the system lower. The localised emissions of gas fired engines will become significant in the near future.

It is expected that the trigeneration or fuel cell system will reduce the operational carbon emissions of the development by 30% to 50%. In order to maximise the potential of the system, smaller modular units are likely to allow for operation independent of the total building thermal or electrical load.

An example of a tri-generation system is shown on the following page outlining the key components, the cogeneration unit which converts gas into electricity and heat, the absorption chiller converting the heat into chilled water and the domestic hot water unit.

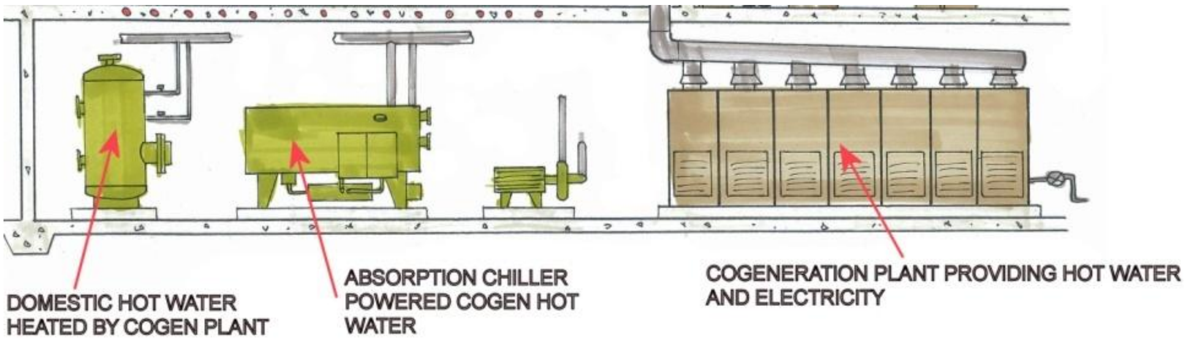


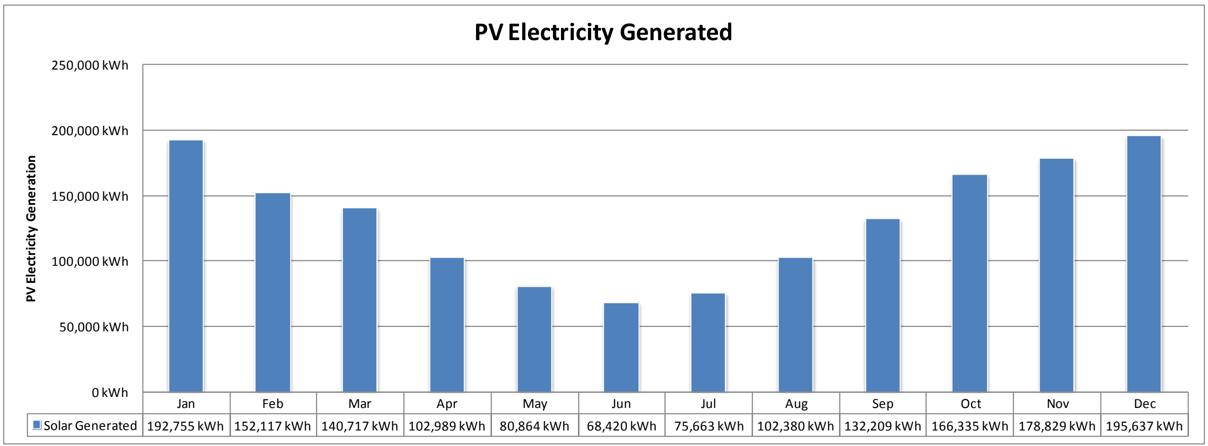
Figure 2: Trigeneration system example showing electricity, hot water and cold water generation

On-site Photovoltaics

As an alternative to using fossil fuels, such as gas fired generation, a roof mounted photovoltaic (PV), solar electric, system will be investigated. Due to the large amount of roof space available the system has the potential to deliver significant energy to the building and tenants. The PV system has the added benefit of providing the largest amounts of energy when the building requires the most energy, during the day and during the summer months.

The potential to integrate the PV system into the building will be explored to allow for the reduction in building materials used, in particular car park shading devices

An example of the potential energy generation of a roof mounted PV system is shown below.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Generated	192,755 kWh	152,117 kWh	140,717 kWh	102,989 kWh	80,864 kWh	68,420 kWh	75,663 kWh	102,380 kWh	132,209 kWh	166,335 kWh	178,829 kWh	195,637 kWh

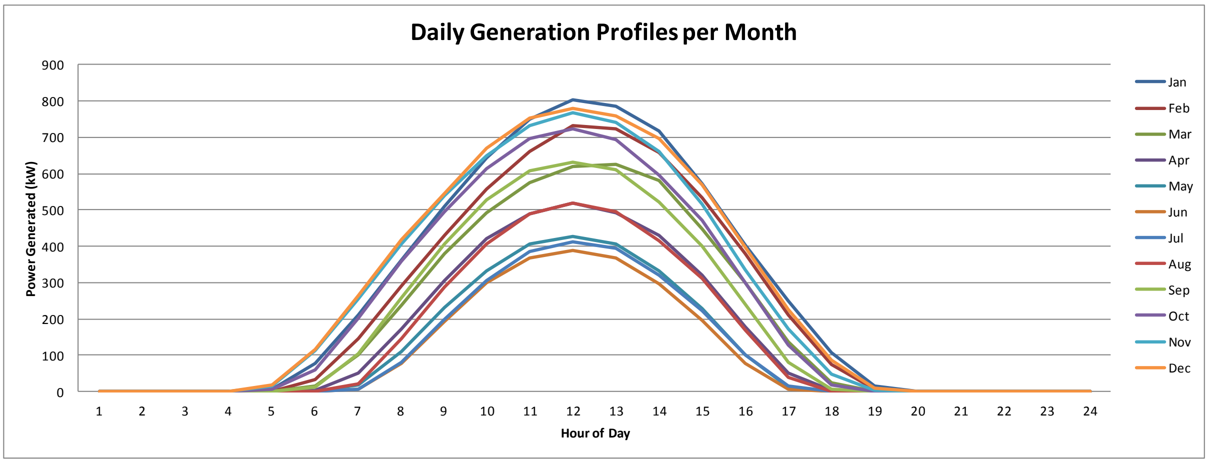


Figure 3: Potential energy generation of a roof mounted PV system

Pedestrian Power

As the footsteps of pedestrians fall on the floor tile-like plate energy is generated. The difference in the potential energy of the human footfall is harnessed and stored by the product. There are limited commercial products available however the sustainable message they provide is worth investigating.

Figure 4: Pedestrian Power

Off-site Solar and Wind

An alternative to installing the low carbon energy systems on the site the option for investing the capital in an off-site solar energy or wind power station will be examined. Due to the scales of economy involved it may be possible to provide far greater amounts of renewable energy to the building and much better rates, providing enhanced sustainability for the building and the tenant.

Figure 5: Offsite photovoltaic and wind energy plant

2.1.7 Energy Monitoring and Metering

All major aspects of the building will have a real time energy monitoring system to enable the facilities management to investigate the buildings energy consumption in real time to provide enhanced building tuning and long term operational efficiency.

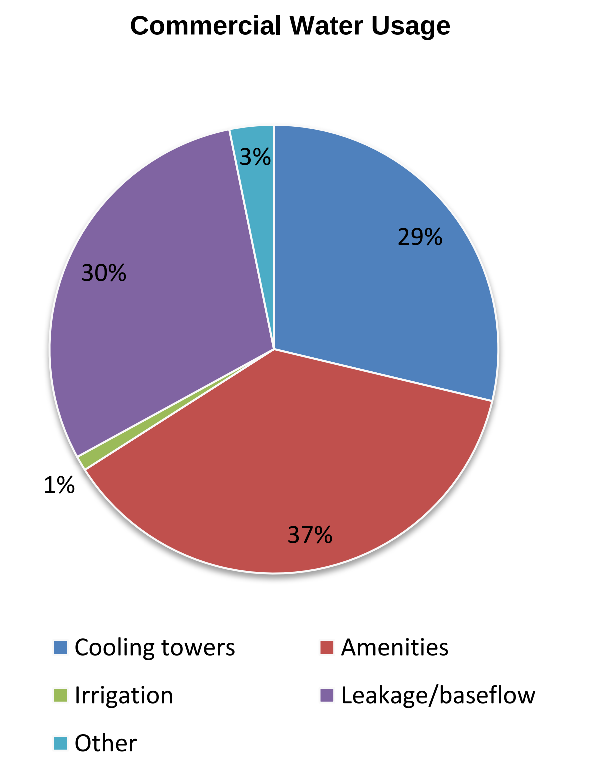
In addition the commercial and retail section of the building will be individually monitored to ensure all future sustainability rating tools can be applied.

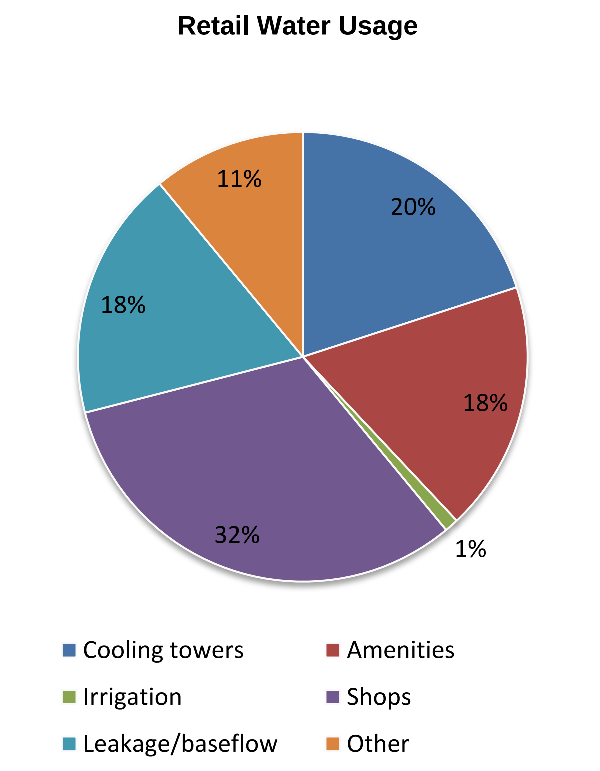
2.2 Potable Water Reduction Strategies

Data produced by Sydney Water indicates that commercial buildings, including retail and office, consume almost 20% of all water used in business.

The following table and chart provides an indication of the level of water consumption for commercial and retail usage.

Benchmark	Commercial Office	Retail
Median market practice with no leaks	1.01 kL/m²/years	1.70 kL/m²/years
Economic best practice	0.844 kL/m²/years	1.68 kL/m²/years
Very well managed building	0.77 kL/m²/years	1.35 kL/m²/years





Reducing potable water consumption provides benefits such as, reduced utility bills and preservation of future water supply. Organisations that adopt strategies to reduce water consumption also portray an image of innovation and awareness to clients, staff and visitors. Incorporating pioneering initiatives often leads to improved communication, management and collaboration throughout an organisation.

This section sets out possible strategies to minimise potable water by building occupants and the operation of building services.

2.2.1 Amenities

Occupant consumption is a major contributor to potable water usage. The following ratings will be considered a minimum to ensure the efficient use of potable water by building occupants:

- WCs at 3L/flush (average) or better;
- Low flush (i.e. waterless or 0.8L/flush) urinals;

- Showerheads at 7.5 L/minute or better;
- Taps at 4.5 L/minute with automatic shut off.

2.2.2 Air Conditioning Systems

Air-conditioning systems and associated plant can be very water intensive. Cooling tower systems should be designed so that the number of cycles of concentration can be calculated by the BMS and will therefore limit the bleed-off flow to achieve a minimum set point of 6 cycles of concentration (or greater).

An alternative to water based heat rejection is an air based system. The air based system has the benefit of not requiring water during its operation, however consumes significantly more energy. An energy and water benefit analysis will be conducted to determine the most sustainable solution.

2.2.3 Rainwater Harvesting

To reduce the consumption of potable water, rainwater will be harvested and stored in the basement to be used for non-potable water requirements such as irrigation, WCs/Urinals flushing and cooling tower make-up water. Based on a collection area of 4,500m^2 it is recommended that a rainwater tank with a storage capacity of 100,000l is installed. The harvestable rainwater will be capable of providing significant water to the cooling towers and WC flushing for the commercial office space.

2.2.4 Fire Systems

Water from fire system testing procedures can be re-used within the building to offset water consumption. The fire sprinkler system is to be designed so that all test and drain down water is harvested to a storage tank in the basement. This could be a sectional water tank in combination with the rain water storage system. The test and drain down water is to be treated and re-used within the development for non-potable water services.

2.2.5 Water Metering and Leak Detection

A system that both monitors and manages water consumption is to be installed. Water metering will be provided to all major water uses within the building, with connections to the BMS ensuring immediate and effective monitoring of water consumption and leakages for simple rectification.

2.3 Building Materials Resource Minimisation

2.3.1 Sustainable Building Products

The following initiatives will be followed with regards to building products:

- Ecologically sensitive products, such as scarce minerals and old-growth forest, will be avoided;
- Preference will be given to materials with a high recycled content and preferred source, including:
    - Where timber is used, it will preferentially be sourced from reclaimed or certified sustainable growth stock. As a minimum, at least 95% of timber must be sourced from either re-used, post-consumer recycled, FSC or AFS certified timber.
    - A proportion of portland cement will be replaced with fly ash or other industrial waste products, and recycled aggregate will be used.

- Wherever feasible, PVC and steel will be sourced from sources capable of achieving the Green Star applicable credits.

2.3.2 Embodied Carbon

Embodied carbon comprises a major proportion of the total carbon footprint of a building. An option to provide an analysis of total carbon and environmental footprint will be considered at key design stages to ensure that design options are prioritised in terms of life-cycle impact and embodied energy/water rather than just day one impacts.

The following items will be considered throughout the design development:

- Sub-structure
  - Maximise recycled content of materials in structural components.
- Super-Structure
  - Maximise recycled content in concrete and formwork.
- Envelope
  - Adopt a low-carbon, lightweight approach;
  - Consider necessity of massing elements;
  - Consider composite materials or dual function elements.
- Internal Walls
  - Consider necessity of internal walls;
  - Consider recycled content or reused materials;
  - Consider low carbon steel framing.
- Internal Finishes
  - Consider setting a recycled content target for all finishes;
  - Consider epoxy or sealed vinyl finishes over vitrified and tiled surfaces;
  - Consider architectural expression of structure rather than needing additional finishes and materials.
- Services
  - Minimise high carbon intensity metals, extent of electrical cabling and ductwork, pipework and plant;
  - Ensure right-sizing of services;
  - Consider vertical transport as a critical element due to the scale of the development - reduce lift car weights and finishes;
  - Review maintainability at schematic design stage;
  - Implement sustainable procurement policy for maintenance and replacement.

2.3.3 Durability and Product Stewardship

All materials will be assessed to ensure that the selections are durable, flexible and recyclable. The manufacturers may be encouraged to implement comprehensive Environmental Management Plan to minimise the impact of their operations. In addition modular components and mechanical fixings will be encouraged to allow for ease of disassembly at the end of the building's life.

2.3.4 Emissions & Toxicity

The development will aim to specify materials with a low emissions content including low-VOC and low formaldehyde content, in order to avoid contaminating the indoor air.

Where alternative materials are available at comparable quality, performance and cost, the following materials should be avoided in construction:

- Asbestos;
- Cadmium;
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene;
- Chlorofluorocarbons (CFCs);
- Chloroprene (Neoprene);
- Formaldehyde (added);
- Halogenated Flame Retardants;
- Hydrochlorofluorocarbons (HCFCs);
- Lead (added);
- Mercury;
- Petrochemical Fertilizers and Pesticides;
- Phthalates;
- Polyvinyl Chloride (PVC) and
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol.

2.3.5 Ozone Depleting Materials

Thermal insulation products which have a zero ozone depletion potential in their manufacture and composition will be preferred; this will reduce the impacts of insulation on the atmosphere.

Air conditioning refrigerants will be selected to have an ozone depletion potential of zero. Additionally the implementation of integrated refrigerant leak detection will be investigated to allow for early identification of leaks to avoid refrigerants leaking into the atmosphere.

2.3.6 Materials Sources

Localised manufacturing will be supported, reducing transport emissions and providing greater security of supply.

2.3.7 Waste Management

A dedicated storage area will be provided for the separation and storage of recyclable waste during operation, allowing for the following waste streams to be separated:

- Glass
- Paper
- Plastics
- Cardboard
- Organics; and
- Metals.

Throughout project design, operation and construction, principles of resource recovery will be applied, so that materials and products are recovered and reused where possible, reducing landfill and saving money.

Some strategies that will be investigated using full life cycle analysis include:

- Innovative waste separation and collection strategies to allow materials to be isolated for reuse;
- A purchasing policy which aims to minimise waste from products and packaging, encourage the use of products which have minimum environmental impact;
- Manufacturers and suppliers will be encouraged to take full responsibility for the life cycle impact of products including ownership at end of life.

3 Creating Spaces for People

With the development aiming to create a working environment for approximately 2,400 office workers and up to 5,000 visitors to the retail spaces it is essential that the building provides a comfortable and healthy environment for everyone. The development is investigating several initiatives to enhance the indoor environment through a multitude of different technologies and design features.

3.1 Daylight Improvement

Appropriate day lighting is essential for users' wellbeing and connection to the outdoors, and for energy efficiency. However excessive daylight can cause glare which is a major IEQ concerns and must be avoided.

The office will be aiming to achieve a minimum hourly illuminance value of 300 lux from daylight alone at task level for at least 50% of the hours between 8a.m. and 6p.m, for at least 30% of the NLA.

External shading and/or automated internal blinds should be provided to eliminate direct glare to each workstation. The following diagrams detail the expected levels of day light for a typical floor plan.

The retail extension will aim to maintain the existing daylight availability to the mall spaces whilst increasing the total number of floors by incorporating a large skylight above the level 6 mall. Voids in the mall will allow the daylight to penetrate the lower shopping levels, enhancing the connection to outdoors for the entire mall.

The following images detail the daylight penetration for the top floor, mid-floor and bottom floor of a typical mall space. The images detail the daylight factor, which is a factor of indoor light compared to external light.

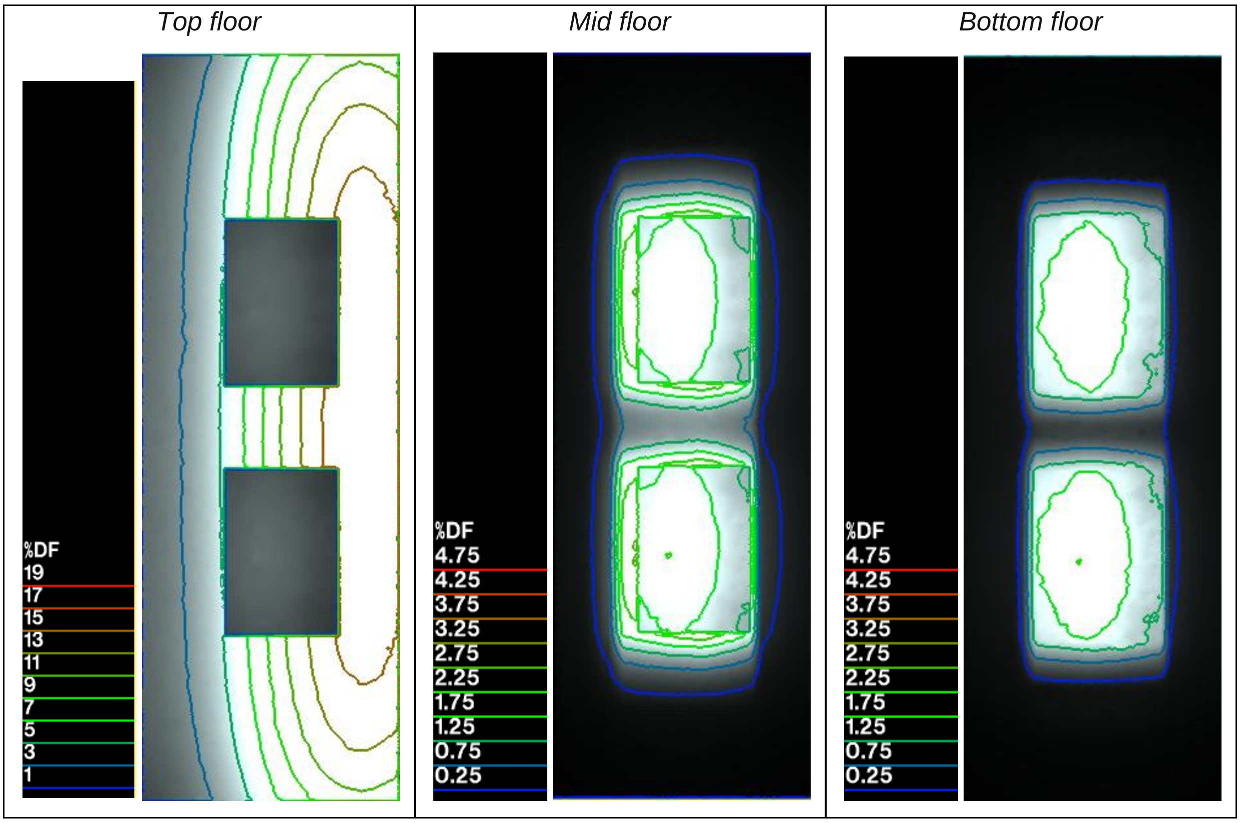


Figure 6: Retail daylight penetration – existing

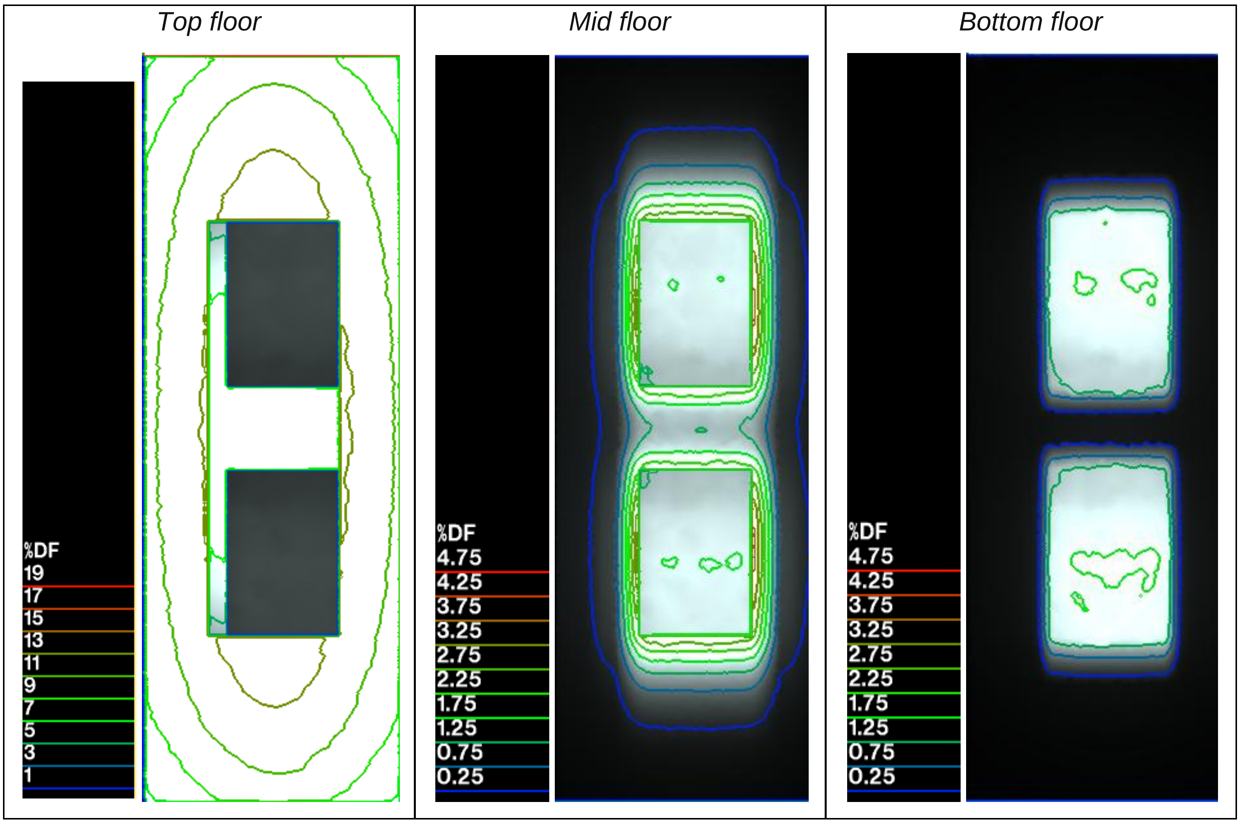


Figure 7: Retail daylight penetration - enhanced

The following design opportunities will be considered throughout the detailed design process to maximise the daylighting potential:

- Glass selection: given the extent of proposed glazing, glass with a moderate VLT (0.4-0.6) should allow sufficient daylight to penetrate the space. Glass with a reflective coating will reduce glare.
- An open plan layout will allow deep daylight penetration. Limit enclosed spaces and high partitions (greater than one meter) near windows and open plan. Where possible glass partitions will be used in place of solid walls.
- Light internal colours improve daylight penetration.
- Blinds that can be adjusted to block glare, but still allow daylight penetration.

3.2 Connection to the Outdoors

Whilst it is difficult to achieve connection to the outdoors in a multistorey retail or office building in an urban environment there are significant health benefits associated with providing access to views. There is increasing evidence that suggests improved access to external views can reduce health problems associated with working inside a commercial office building. Symptoms including eye strain and headaches are attributed to extended periods of time spent reading paperwork or in front of computer monitors. To combat these problems, occupants are encouraged to refocus their vision periodically throughout the day to the outdoor environment. As such, it's recommended that new office developments provide occupants with access to external views to improve occupant health and well being.

Calculations were completed for two of the office levels to determine the percentage of NLA that has access to external views. As prescribed by the Green Building Council of Australia (GBCA), the view must be uninterrupted for eight meters from the perimeter of the building to achieve compliance. Levels eight and above have between 40% and 50% of the total NLA with access to external views, with placement of the buildings core in the centre of the floor plate the area could increase beyond 60%. The aim of these calculations is to work with the tenants to allow 100% of workstations to be located with the zones of external views.

The connection to the outdoors may be enhanced further by:

- Thin floor plates allow more work areas to be located close to windows. Locate core zones away from window.
- Internal plants provide the sensation of being connected to the outdoors.

Naturally ventilated pods provide a connection to outdoor conditions.

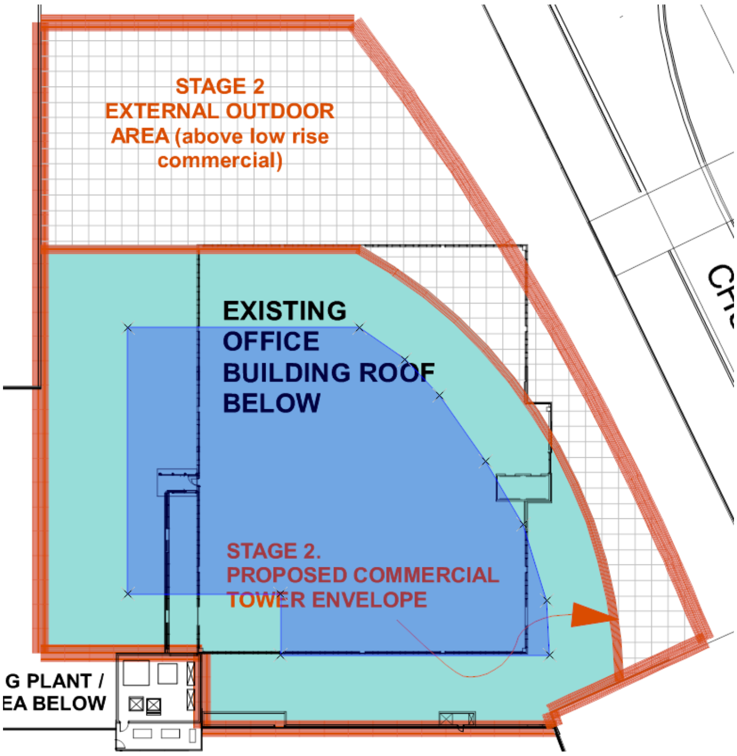


Figure 8: Level eight and above access to views

3.3 Further Indoor Environmental Quality

In addition to the building form based indoor environment quality improvements noted above the following items will be considered throughout the detailed design of the development.

3.3.1 Artificial Lighting

It is important that the right amount of light is delivered for building users to comfortably achieve their specific tasks. The spaces will be flexible and adaptable, and the lighting design must be too.

The artificial lighting system should deliver uniform light levels within individual spaces, be integrated with the daylight design, be energy efficient, and allow users a high degree of control. The main features to consider are shown in the following list:

- Occupant controlled dimming.
- Task lighting.
- Daylight linking.
- Motion sensors.
- Intuitive switching so users know which switches control which lights.
- Individually addressable / adaptable lighting system.
- Uplighting to improve light uniformity.

3.3.2 Controlling Indoor Pollutants

The key indoor pollutants are carbon dioxide (CO_2), formaldehyde, volatile organic compounds (VOCs), and moulds. Carbon dioxide is the main indoor pollutants emitted by humans and correlates with human metabolic activity. Carbon dioxide at levels that are unusually high indoors may cause occupants to grow drowsy, get headaches, or function at lower activity levels.

Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short and long term adverse health effects. Concentrations of many VOCs are consistently higher indoors than outdoors. VOCs are emitted by a wide array of products numbering in the thousands (typically paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers).

Mould can occur when moisture is allowed to remain in building, this may cause mould mildew to propagate and release allergenic spores into the air. The primary hazard of mould growth, as it relates to indoor air quality, comes from the allergenic properties of the spore cell wall. Mold is known to trigger episodes in persons that already have asthma.

The design will investigate many items to improve the indoor air quality:

- CO2 levels will be monitored and limited to 600ppm, at which point outside air levels will be increased.
- All materials installed in the building will be reviewed for formaldehyde and VOC emissions.
- External and internal dirt tracking mats at all entrances.
- Air filtration system based on indoor plants (e.g. Green Lung) and/or indoor plants to passively filter the air.
- Provide a dedicated exhaust system for pollution-generating spaces (e.g. photocopy rooms, kitchens and breakouts).

3.4 HVAC to Support Excellent IEQ

The HVAC system delivers and filters the internal air and its design is crucial to good IEQ. The system will provide:

- A healthy supply air
- A system easily controlled by users (temperature, air speed, air direction, having it on or off)

- Highly effective distribution of air within the spaces (air change effectiveness greater than or equal to 1).

Ideally, the air leaving the building will be cleaner than the air entering. To enable this to occur the building will incorporate the following features:

- Underfloor air distribution (displacement ventilation) systems which are most effective at removing pollutants and distributing air effectively. They are also less likely to cause draughts, and offer user control.
- Incorporating naturally ventilated or mixed-mode “pods” or spaces into the design would be a way of providing users with the opportunity for natural ventilation when conditions are suitable, without adversely affecting the entire floor.
- Delivering the supply air via the workstation (e.g. UCI Task Air) will be a potential option for the tenant to allow for user control. This can be combined with underfloor displacement ventilation.
- High performance filters will need to be installed to filter outside air.
- Include a CO_2 monitoring and control system for all spaces, especially enclosed rooms.

3.5 Thermal Comfort

People’s perception and idea of thermal comfort varies significantly, targeting a predicted mean vote (PMV) between -0.5 and +0.5 based on ISO 7730 will help ensure the majority of people (90%) are neither too hot nor too cold. The following initiatives will be included in the building:

- Underfloor displacement with user control provides exceptional thermal comfort.
- Manage people’s expectations and connection to the outdoors by varying the internal temperature setpoints with external temperatures (also saves energy).
- Facade design and glass selection is very important; heat gains and losses must be moderated and thermal bridging should be avoided.
- The facade should be well sealed to avoid draughts and air leakage.

3.6 Acoustics

The office will be designed to be neither too quiet nor too noisy so that a level of privacy can be maintained and users are not distracted from their tasks.

The development will aim for a design where:

- Building services noise in general office spaces is less than 40dB(A)LAeq;
- The sound level does not exceed 40dB(A)LAeq within open plan office spaces
- Meeting rooms and enclosed offices have a sound transmission class (STC) rating of at least 50 (fitout consideration).
- Reverberation times (T60) no more than 0.8 and 0.6 are achieved for open plan offices and conference rooms / enclosed offices respectively (fitout consideration).

4 Codes and Ratings

The building will be subject to numerous voluntary and mandatory building codes and metrics to measure the performance of the rating. This section of the report will outline the main codes and ratings and identify the projects response.

4.1 Building Codes of Australia - Section J

The development is required to comply with the BCA Section J for Energy Efficiency. BCA Section J covers items including:

- Building fabric.
- External glazing.
- Building sealing.
- Air movement.
- Air conditioning.
- Artificial lighting and power.
- Hot water supply.
- Access to maintenance.

The building is being design with a high-performance facade and high-efficiency HVAC and electrical services. In order to take into account the complexities of the facade and building design, an alternative verification model will be undertaken during design development.

4.2 NABERS Energy and Water

The National Australian Building Environmental Rating Scheme (NABERS) is a suite of tools designed to allow for buildings of a similar type to be rated in terms of its operational sustainability. The NABERS suite includes energy, water, waste and indoor environment quality.

The NABERS Energy tool is a rating of the performance levels of a building in relation to CO_2 emissions per m^2 per year. Emission are normalised for Net Lettable Area, occupancy hours and location, and then used to calculate a star rating. Six stars is currently the highest available rating, and represent exceptional building energy performance.

The NABERS Water tool is a rating of the performance levels of a building in relation to total potable water consumption per year. Emission are normalised for Net Lettable Area, occupancy hours and location, and then used to calculate a star rating. Six stars is currently the highest available rating, and represents exceptional building energy performance.

What do the star ratings mean?

- **6 stars - Market leading performance -** You have achieved the highest possible rating. Your rating indicates you have combined superior equipment selection, operation and management to demonstrate your commitment to energy/water conservation.
- **5 stars - Excellent performance -** This rating represents outstanding performance in the current market and ranks the building in approximately the top 20%. Your building demonstrates strong performance, reflecting good equipment and management practices.

- **4 Stars - Above average performance -** This rating represents above average performance. Your building probably has some energy/water efficient equipment and management practices and reflects an awareness of the importance of conserving water. Some improvements may still be possible.
- **2.5 – 3 Stars - Average performance -** This rating represents average building performance. Your building possibly has some elements of energy/water efficiency in place. There is still scope for significant improvement, and changes will have a notable impact on this building's energy/water use.
- **2 Stars - Below average performance -** This rating represents below average building performance. Your building is unnecessarily wasting energy/water. Changes to water efficiency will have a significant impact on water usage.
- **1 Star - Poor performance -** This is a poor rating, indicative of poor energy/water management and/or outdated equipment. Your building is using a lot of unnecessary energy/water. There are changes that can be implemented to reduce energy/water consumption, reduce operating costs and reduce the burden on resources.
- **0 Stars - Very poor performance -** Your building has poor energy/water efficiency and lies outside the rating scale. It is very likely that energy/water is being wasted and there will be a range of simple improvements that could bring your water use within the rating scale. This will reduce your operating costs and reduce the burden on resources.

4.3 Green Star

The development is being designed to exceed minimum requirements in terms of Ecologically Sustainable Design (ESD), and is aiming to achieve the following green building ratings:

- 4 star Green Star - Retail (v1) rating (formal certification not targeted, design intent only);
- 5 star Green Star –Office (v3) rating;

Green Star is a comprehensive sustainability design tool which assesses the environmental impact of a building over a range of environmental indicators, from management and ecology to energy and water use, material selection and waste production. Categories are weighted according to their perceived environmental importance, which varies between building sectors and across States.

Points are awarded in the following categories:

- Management
- Indoor Environmental Quality
- Energy Conservation
- Transport
- Water Conservation
- Ecology
- Materials
- Emissions
- Innovation

A 4 star Green Star rating requires a total of 45 weighted credit points to be achieved in the aforementioned categories, a 5 star Green Star rating require 60 points. Sufficient weighted credits have been selected to achieve this rating, with additional points identified for further development during the detailed design stage. Based on the proposed design response the predicted performance in each respective environmental category is tabulated in the following appendices.

5 Appendix A: Green Star – Retail v1 Strategy

6 Appendix B – Green Star – Office v3 Strategy