University Of Melbourne
Economics & Commerce Building
Building Users Guide

January 2009
AEM0901100.0.2

Client

University of Melbourne

Advanced Environmental

Lincolne Scott Australia Pty Ltd
ABN 47 005 113 468
Level 5 Midtown Tower
246 Bourke Street Melbourne
Victoria 3000 Australia
Telephone 61 3 8663 7880
Facsimile 61 3 8663 7800
melbourne@lincolnescott.com
lincolnescott.com

EXECUTIVE SUMMARY

This Building Users' Guide has been created to enable the occupants and users of the Economics and Commerce Building at the University of Melbourne to understand and achieve the intended environmental objectives and performance of the building, in its everyday operation.

The building was designed to achieve the following benchmarks:

- 5 Star Green Star - Education rating under the Green Building Council of Australia (GBCA) Pilot scheme
- Reduced Carbon Footprint, when compared to typical education buildings
- Reduced Water Usage, when compared to typical education buildings

The Building Users Guide is a progressive and adaptable document which needs to be continually updated to reflect changes in operation and other upgrades to the building. Energy and Water targets should be frequently reviewed and adjusted to match changes in occupants and to strive for continual improvement in operation. It is the Building Owner's responsibility to ensure that this guide is maintained and up-to-date.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Issue/Status	Revision	Date Issued	Author	Checked	Approved	Comment
Draft	P1	28/08/09	KLP	BAF	DGJ	For Approval / Comment
Final	A	4/02/09	KLP	BAF	DGJ	For submission

1 Energy and Environmental Strategy

The Economics & Commerce (E&C) Building at the University of Melbourne has been designed and constructed such that it achieves a 5 Star rating under the GBCA Green Star Education Pilot. The building reflects "Australian Excellence" in its environmental features with initiatives in place to reduce its carbon footprint and water consumption.

1.1 Energy Efficient Design

Some of the energy efficient features included in the E&C building are listed below. These features and strategies provide both economic and environmental savings to the building users and its occupants:

1.1.1 Facade Design

The E&C building incorporates an innovative façade. Its unique frit pattern and external shading elements reduce the solar heat gain to the building interior while maintaining day lighting levels.

The main curtain wall facade of the building is a grey tinted double glazed unit (DGU) with low-e coating and baked ceramic frit pattern applied to surface 1 (on the outside) of the facade panels to the south and part of the east facade, and applied to surfaces 1 and 3 on the north, west and remainder of the east facade.

Figure 1: Facade Design

This is an innovative practice as frit is normally not applied to surface 1 due to issues of ongoing maintenance requirements and the risk of the aesthetics of the facade being reduced over time. Through development undertaken with the glass manufacturers, this glazing system has incorporated measures to minimise the maintenance and degradation of the facade system over its life. This innovation will help drive a change of industry standards to the delivery of frit applications.

The frit is designed to provide 50% coverage of the glass to usable floor areas (UFA) exposed to direct sunlight. The E&C building incorporates an innovation facade design to reduce solar gain, and the subsequent load on the HVAC system, while maximising daylight penetration, improves the indoor environment quality for the occupants.

When the fritted glazing was compared to one without frit it was found that the application of frit to 50% of the facade reduced the overall annual chiller load by 20,645 kWh/annum, a saving of 15% compared to the same glazing unit without frit. This is a saving of 27,665 kg Carbon Dioxide equivalent per year due to the innovative facade alone.

In addition, this high performance facade permitted the installation an innovative chilled beam air conditioning system which is a first for an education building in Australia.

1.1.2 Efficient Heating, Ventilation and Air-conditioning (HVAC) design – the use of Chilled beam Technology

The E&C building incorporates a chilled beam air conditioning system to the majority of its usable floor area.

Chilled beams offer the following environmental benefits:

- Up to 80% reduction in air handling fan energy compared to Variable Air Volume (VAV) systems (standard air-conditioning system) due to the reduced volumes of air required;
- Higher central chiller plant efficiencies;
- Improved outdoor air rates - 100% improvement on the minimum statutorily required fresh air rates;
- Improved indoor air quality due to the system being a once through 100% outside air system i.e. no recirculation of air;
- Reduced mechanical plant space, core area for ductwork and floor to floor height – this meant that less building materials were required; and,
- Good thermal comfort through convective and radiant cooling.

Air quality is one of the most important factors of an indoor environment. Indoor Air Quality (IAQ) includes a variety of factors, such as ventilation and fresh air, humidity, drafts and chemical & contaminant levels in the air. According to a number of sources, poorly designed, poorly ventilated and/or poorly maintained buildings generate conditions that may affect student and staff health, performance and concentration. Research into the office environment has found similar results.

Therefore, the selection of an air conditioning system that addresses all of these factors will have an improved indoor environment for the building occupants.

1.1.3 Control of Services - when area not in use

In general, most HVAC systems are typically designed to provide constant indoor temperature and operation of other services during standard building occupancy hours. However, in practice various spaces throughout the building will be occupied only intermittently between these hours.

A combination of sensors has been installed throughout the building including motion sensors to control energy and temperature sensors to provide temperature setbacks.

These strategies are employed in the following spaces:

- Basement 1 and Level 1 Lecture Theatres
- Tutorial spaces and seminar rooms on Levels 2 to 6
- Individual Offices Levels 7 to 12

<u>Control Strategy Description</u>

For each of the above spaces, control sensors will be installed and linked to the Building Automation System (BAS) to ensure the air conditioning system is shutdown or the temperature is set back when the spaces are unoccupied.

In addition, each space will be controlled via time clock to shut the air conditioning system down during unoccupied hours.

Basement 1 and Level 1 Lecture Theatres (Displacement A/C Systems)

Based on the teaching timetable for the lecture theatres during periods of teaching the control sensor (motion sensors) input shall be used to setback the theatre room temperature during periods when the theatres are unoccupied.

During periods outside the teaching timetable the control sensor input shall be used to shutdown the air conditioning when the theatres are unoccupied.

Tutorial Spaces and Seminar Rooms Levels 2 to 6 (Active Chilled Beams)

Based on the teaching timetable for the above room and during periods of teaching, the control sensor (motion sensor) input shall be used to setback the room temperature during periods when the rooms are unoccupied.

Air conditioning shut down for unoccupied periods outside the teaching timetable shall involve closing the outside air supply motorised damper and closing the modulating chilled meter valve serving the active beams.

Individual Offices Levels 7 to 12 (Passive Chilled Beams)

In addition to the above teaching spaces there are a very large number of individual academic offices for lecturers and staff (approximately 200 in total) on the academic office levels 7 to 12.

The air conditioning design for these offices includes the provision of outside air via a ceiling swirl diffuser in each office. This is 100% outside air and is supplied to the room at approximately room temperature i.e. 20 to 22°C. The air conditioning to these offices is via passive chilled beams with the beam in each office being individually controlled from each office temperature sensor. The chilled water supply to the passive chilled beam is varied via a control valve operated by the room temperature sensor. The chilled water flow to the beam is varied and as such the cooling output depending on the space temperature which is driven by the occupant of the space. The passive beam chilled water valves are also connected to the BAS which will also close the chilled water valves based on a time schedule.

Air conditioning shut down for periods outside the teaching timetable shall involve closing the floor outside air supply motorised dampers and closing the modulating chilled water valves serving the passive beams.

1.1.4 Energy Efficient Lighting Design

Lighting accounts for 30% to 60%[1]of the energy typically consumed in buildings. It is also is the primary source of heat gain and so must be treated by a building's cooling system.

Good lighting zoning allows areas that are not in use to be switched off when not required. At ECUoM the lighting zoning has been wired to enable individual switching of lighting over zones no greater $100m^2$.

[1] US Environment Protection Agency (2004), *Energy Star Building Upgrade Manual,* US EPA, Washington, USA.

The use of motion and daylight sensors have been installed to aid in the reduction of energy consumed with the lighting to small and enclosed spaces being switched off when not required.

Finally, energy efficient T5 light fittings have been installed with reduced energy consumption compared to older lighting technologies.

1.1.5 Other Environmental Features

Other environmental design features include:

• Location of stairs close to the glazed facade to gain access to natural light and reduce the requirements of artificial lighting

• Location of stairs within the view of entry points to the building to provide an alternative and convenient means of travel to the floors then the use of the lifts

• The stairwell is naturally ventilated by the spill air from the lower floors

2 Monitoring and Targeting

The E&C building has been designed to minimise energy and water usage. The following sections provides the building energy and water targets consumption benchmarks to achieve the targeted performance, and should be used as a guide for understanding this building's performance.

2.1 Energy

2.1.1 Metering and Sub-metering Strategy

Energy meters are installed for the main incoming feeders to the building, floor lighting & power distribution boards and the major load feeders (feeders with loads exceeding 100kVA).

Energy meters are interfaced to the Building Automation System (BAS), so that the energy consumption can be monitored from the BAS computer in the building manager's room.

2.1.2 Targets and Benchmarks

Table 2Table 2 represents the monthly targeted energy figure breakdown for each building item. Due to the metering arrangements that have been established in the Building Automation System (BAS) various equipment and meters have been grouped together. Table 3 represent the targeted energy figures as will be monitored and read through the BAS.

2.2 Water

2.2.1 Metering and Sub-metering Strategy

Water meters are installed to monitor water consumption for all major water uses in the project, including:

- Bathrooms
- Fire system water
- Irrigation
- Rainwater supply
- Domestic hot water
- Recycled water supply

Water meters are interfaced to the Building Automation System (BAS), so that the water consumptions and trends can be monitored from the BAS computer in the building manager's room.

2.2.2 Targets and Benchmarks

The following table provides the base building energy target in order to achieve the aimed rating.

	Potable Water		Non-Potable Water		
Month	**Shower**	**Wash Hand Basins**	**Muller 3C**	**Toilet Flushing**	**Rainwater**
January	117,223	39,556	142,481	320,292	9,438
February	105,879	35,728	177,661	289,296	-
March	117,223	39,556	73,671	320,292	34,320
April	113,442	38,280	7,658	309,960	40,841
May	117,223	39,556	-	320,292	32,432
June	113,442	38,280	-	309,960	38,438
July	117,223	39,556	-	320,292	15,787
August	117,223	39,556	-	320,292	46,847
September	113,442	38,280	-	309,960	21,107
October	117,223	39,556	4,061	320,292	30,202
November	113,442	38,280	6,940	309,960	48,906
December	117,223	39,556	33,532	320,292	92,664

Table 1: Monthly water targets

	Electric														Gas	
	Chiller (Low Temp) (kWh)	Chiller (High Temp) (kWh)	AHU Fans (kWh)	Muller 3C Fans (kWh)	Condenser Water Pumps (kWh)	Chilled Water Pumps (kWh)	Heating Hot Water Pumps (kWh)	Mechanical Fans (kWh)	Lifts (kWh)	Hydraulic Pumps (kWh)	Lighting (kWh)	Power (kWh)	Blackwater Plant (kWh)	Boiler (kWh)	Domestic Hot Water (kWh)
January	14,505	5,670	13,032	1,211	3,766	3,716	235	4,240	6,667	420	23,096	217	1,555	16,130	4,534
February	17,678	6,910	11,771	1,475	4,590	4,529	310	3,829	6,022	379	20,860	217	1,405	21,270	4,095
March	12,766	4,990	13,032	1,065	3,314	3,271	171	4,240	6,667	420	23,096	217	1,555	11,765	4,534
April	6,616	2,586	12,612	552	1,718	1,695	134	4,103	6,452	406	22,351	217	1,505	9,185	4,388
May	3,555	1,389	13,032	297	923	911	433	4,240	6,667	420	23,096	217	1,555	29,734	4,534
June	2,640	1,032	12,612	220	685	676	539	4,103	6,452	406	22,351	217	1,505	36,994	4,388
July	2,488	972	13,032	208	646	637	690	4,240	6,667	420	23,096	217	1,555	47,349	4,534
August	3,020	1,180	13,032	252	784	774	588	4,240	6,667	420	23,096	217	1,555	40,354	4,534
September	3,293	1,287	12,612	275	855	844	363	4,103	6,452	406	22,351	217	1,505	24,935	4,388
October	5,003	1,956	13,032	418	1,299	1,282	278	4,240	6,667	420	23,096	217	1,555	19,070	4,534
November	6,190	2,420	12,612	517	1,607	1,586	194	4,103	6,452	406	22,351	217	1,505	13,280	4,388
December	10,065	3,934	13,032	840	2,613	2,579	163	4,240	6,667	420	23,096	217	1,555	11,200	4,534
Total	**87,819**	**34,326**	**153,443**	**7,330**	**22,800**	**22,500**	**4,098**	**49,921**	**78,499**	**4,943**	**271,936**	**2,602**	**18,310**	**281,266**	**53,385**

Table 2: Monthly Energy Breakdown Target

	MDB-13-1A + MDB-13-1B (kWh)	MDB-13-2 + MDB-13-3 + MDB-13-4 + MDB-B2-1 + MDB-B2-2 + MDB-GM-1 (kWh)	MDB-13-5 (kWh)	TDB-3 + TDB-4 + Main Feed (kWh)	DB-LP Main Feed + Sub Swbd BL1 (kWh)	Main Gas Meter (MJ)
January	28,868	13,032	235	8,222	23,733	74,390
February	35,182	11,771	310	7,427	21,456	91,314
March	25,406	13,032	171	8,222	23,733	58,676
April	13,167	12,612	134	7,957	22,974	48,863
May	7,075	13,032	433	8,222	23,733	123,365
June	5,253	12,612	539	7,957	22,974	148,975
July	4,951	13,032	690	8,222	23,733	186,779
August	6,010	13,032	588	8,222	23,733	161,597
September	6,554	12,612	363	7,957	22,974	105,563
October	9,958	13,032	278	8,222	23,733	84,974
November	12,320	12,612	194	7,957	22,974	63,605
December	20,031	13,032	163	8,222	23,733	56,642
Total	**174,775**	**153,443**	**4,098**	**96,809**	**279,481**	**1,204,744**

Table 3: Monthly metering targets

2.3 Indoor Environment Quality

2.3.1 Control Strategy

A combination of CO_2 sensors are installed to help control indoor contaminants by increasing the outside air supply when internal concentrations reach a set limit.

The CO_2 sensor are located in the return air duct and monitors CO_2 concentration. At a clean air reading of 400 ppm the outside air damper minimum position is set to the clean air value. As the CO_2 level increases to 800 ppm, the outside air damper minimum is modulates open toward the high CO_2 damper minimum.

The VOC sensors provide monitoring of the inside air conditions. A TVOC (Total Volatile Organic Compounds) sensor in the return air duct monitors the VOC air quality levels. The VOC sensor is also called a mixed gas sensor and senses multiple gas types to give an indication of general air quality.

2.3.2 Targets and Benchmarks

The following table provides the minimum indoor environmental quality settings that are monitored and controlled.

Sensor	Setting
Carbon Dioxide (CO_2)	800 ppm
VOC Sensor (mixed gas sensor)	Alarm at 500 $\mu g/m^3$

2.4 Waste

2.4.1 Strategy

A full co-mingle materials of recyclable Waste is collected by Speedie Waste Pty Ltd (contact Vince Barilla Ph: 0418 174 556) each morning Monday-Friday before 7am. The recyclable waste is then delivered to Visy Recycling to be sorted in the MRF (Material Recovery Facility).

2.4.2 Targets and Benchmarks

The weight of recyclable material should be continually monitored and recorded. This will assist in the knowledge of how much waste is being recycled.

3 Building Services

3.1 Heating, Ventilation and Cooling Strategy

3.1.1 Basement 1/Basement 2 Theatre Air Conditioning and Ventilation

The basement 1/basement 2 theatre is conditioned through the application of displacement air conditioning. It is served by a variable volume 100% outside air system consisting of a single air handling unit (AHU) which provides ventilation, cooling and heating to the space. Air delivery is via low level displacement supply air grilles that are installed into the vertical element behind the occupant's seat.

The system is also fitted with run around coils that recover energy from the 'tempered' air as it leaves the space, this acts to pre-heat/pre-cool the outside air before it is conditioned via the main air handling unit, reducing the energy required to treat the outside air.

CO_2 sensors are located within the theatre and are used to modulate the supply fan speed via a variable speed drive (VSD) to reduce the fan power consumption.

3.1.2 B1 Gathering Area Air Conditioning and Ventilation

The B1 gathering area is served by a single constant volume re-circulating air handling unit which provides ventilation, cooling and heating to the space via conventional ceiling mounted supply air diffusers and return air grilles.

A CO_2 sensor within the gathering area constantly monitors the level of occupancy and maintains the required outside air ventilation levels to ensure that the contaminant level in the area remains at a reasonable level. As the level of occupancy within the area drops, the variable speed fan is slowed (providing less outside air and reducing the energy consumed by the fan).

As the level of occupancy within the space increases, the variable speed fan is increased (providing more outside air to cope with the increased load).

3.1.3 Ground Floor Air Conditioning and Ventilation

The ground floor comprises several areas for which the following systems are installed:

a) Berkeley Street entry and southern seating area

   I. Mixed mode operation, normally naturally ventilated with conventional air conditioning/heating is available via a constant volume air handling unit.

   II. Floor hydronic slab heating

b) Lift Lobbies and ICT entry corridor

   I. Natural ventilation

   II. Floor hydronic slab heating

c) Administration Offices

   I. Conventional air conditioning and heating via a constant volume Air Handling Unit.

d) Cafe Tenancy

   I. Conventional air conditioning and heating via a constant volume Air Handling Unit.

Natural ventilation is used for the ground floor lobby areas when the ambient conditions are favourable.

When cooler/warmer conditions are required within the southern lobby seating area, the southern facade natural ventilation louvres close and the air conditioning system is started to provide localised cooling.

The administration and cafe air handling units provide cooling and heating to these areas.

Floor hydronic slab heating is provided to all the lobby areas for winter heating.

Hydronic underfloor heating provides an effective heating system, with relatively low associated greenhouse gas emissions and is a particularly effective heating method in areas with high ceilings.

While hydronic underfloor heating has many advantages, it does have a slow response time due to thermal lag. However, the foyer is a circulation space, which enables a broader temperature band to be accepted compared with permanent work areas.

The outside air supply is modulated based on CO_2 reading.

3.1.4 Level 1 Air Conditioning and Ventilation

Level 1 comprises several areas for which the following systems are installed:

a) Student work area, corridor, lift lobbies and waiting area

Mixed mode operation , normally naturally ventilated with conventional air conditioning / heating available via a constant volume air handling unit.

b) Administration

Conventional variable air volume (VAV) air conditioning and heating via an air handling unit.

c) Group Meeting Space/Seminar Room

Conventional air conditioning and heating via a constant volume air handling unit.

d) 100 Seat Lecture Theatre

Displacement air conditioning and heating via an air handling unit.

Natural ventilation is used for the Level 1 open areas when ambient conditions are favourable.

When cooler/warmer conditions are required within these areas the natural ventilation louvres on the Level 1 south and north facades close and the AHU is started to provide cooling/heating.

The administration air handling unit provides cooling and heating via variable air volume (VAV) boxes. The variable air volume boxes act to vary the air volume to suit the internal conditions.

The group meeting space/seminar room air handling unit provides cooling and heating via a constant volume varying air temperature operation.

The 100 seat theatre is conditioned/heated from an air handling unit through the application of displacement air conditioning, similar to the basement 1 lecture theatre.

100% outside air economy cycle is provided to the air handling units, and the outside air supply is to be modulated based on CO_2 reading for energy conservation.

3.1.5 Ground, Level 1 and Stair Natural Ventilation

The most significant benefit of adopting the naturally ventilated ground floor lobby and first floor circulation spaces is the reduction in energy usage, and consequent reduction in green house gas emissions. Other benefits include improved ventilation rates, lower running costs, and lower installed costs for the mechanical services. In terms of thermal comfort, the effect of adopting natural ventilation is that you are unable to gain full control of the internal conditions during hot weather and windy conditions.

To reduce the number of hours that the occupants experience discomfort on Level 1, it is proposed to provide a mixed mode system to the circulation space, student enquiries area and student work area on this level. This essentially retains air conditioning infrastructure to the entire level 1 occupied space, removing the need for hydronic underfloor heating, and retains the natural ventilation louvres with openable dampers.

The air conditioning system operates when the natural ventilation louvres are closed. The set point conditions can be adjusted, however, are notionally set to maintain conditions between 20°C and 29°C inside the occupied space.

Natural ventilation motorised openable louvres/dampers are located as follows:

a) Ground level — North Facade, South Facade

b) Level 1 — North Facade, South Facade

c) Level 13 — Top of Stair

The fire stair doors are normally open from the ground to level 6 to allow natural ventilation and spill air from the teaching levels to be relieved up the stairs. The fire stair doors on levels 7 to 12 is normally held closed.

The cross section schematic following, diagrammatically represents the system.

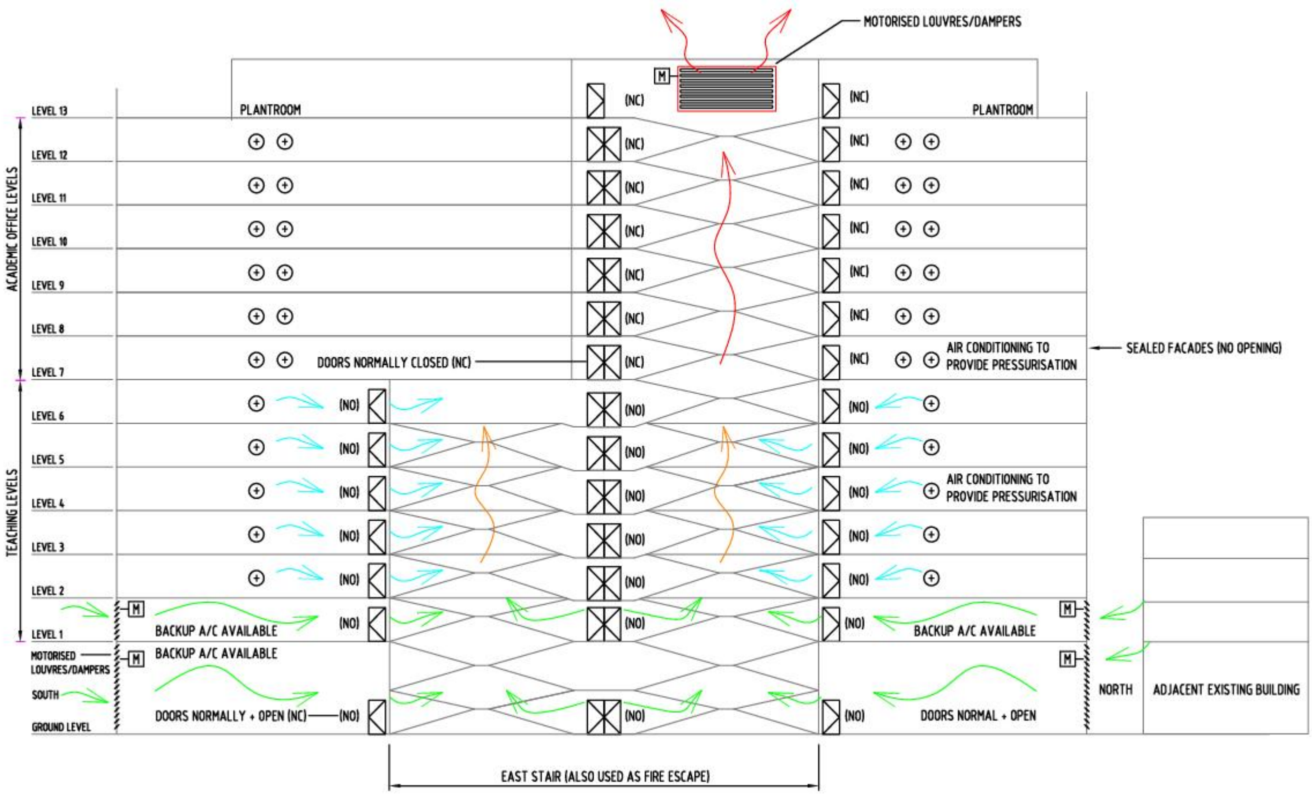

Figure 2: Air schematic of Building

The adoption of natural ventilation is primarily to enable energy savings for a large percentage of the year and will be used whenever ambient conditions permit.

3.1.6 Teaching Levels 2 to 6 Air Conditioning and Ventilation

Levels 2 to 6 consist of several areas for which the following systems are installed.

a) Teaching spaces including L2 tutorial and seminar rooms and level 6 learning centres and seminar rooms

   I. Local active chilled beams

   II. Dehumidification, ventilation and heating via air handling plant.

b) Administration offices, Meeting rooms and Student work areas

   I. Local passive chilled beams

   II. Dehumidification, ventilation and heating via air handling plant.

c) Open access computer lab interior

   I. Local active chilled beams

   II. Dehumidification, ventilation and heating via air handling plant

d) Open access computer lab perimeter

   I. Local active chilled beams

   II. Dehumidification, ventilation and heating via air handling plant

Levels 2 to 6 contain a number of teaching labs and seminar rooms. Each of these areas is served by a number of local active chilled beams to meet the space sensible cooling and heating requirements.

100% conditioned outside air is delivered directly to each of these active beams by dedicated outside air handling units.

The remaining areas on each of level 2 to level 6 are served by local passive chilled beams. 100% conditioned outside air is delivered to these areas via ceiling mounted swirl diffusers.

3.1.7 Academic Office Levels 7 to 12 Air Conditioning and Ventilation

The outside air supply for the teaching levels 2 to 6 and academic office levels 7 to 12 is provided by 100% outside air AHUs.

The perimeter areas consist primarily of circulation corridors and a number of low occupant density academic offices. These areas are divided into 4 main zones and consist of a north, east, south and west.

The interior areas of these levels consist of academic offices, meeting rooms and circulation areas and are also served by outside air systems and passive chilled beams. The interior floor areas of these levels are served by air handling plant.

The chilled beams installed throughout levels 7-12 are passive type and are installed locally within spaces above the perforated ceilings.

3.1.7.1 Passive Beams

The chilled beams respond to temperature sensors located within each space, providing the required sensible heating capacities. The sensible cooling capacity of the beams are adjusted by modulating the flow rate of high temperature chilled water that is provided to the beams.

3.1.7.2 Ventilation Philosophy

Outside air is introduced to the spaces in accordance with ventilation requirements. Outside air temperature is conditioned to between 16 to 20°C.

3.2 Heating Systems

The Heating Hot Water (HHW) for the building heating systems is provided by 3 natural gas fired boilers.

The HHW system is provided with a water make-up system comprising automatic refill unit which prevents backflow.

3.3 Cooling Systems

The chilled water for the building air conditioning systems is provided by 3 water cooled chillers located in the roof plantroom on level 13.

The chillers are used to produce two different temperature chilled water flow and return systems as follows.

a) Low Temperature System

Flow and return water temperature of nominal 7°C and 14°C respectively.

Chilled water used in AHUs to cool and dehumidify outside air and to supply a plate heat exchanger.

b) High Temperature System

Flow and return water temperatures of nominal 15°C and 18°C respectively.

Chilled water used in passive and active beams. Higher temperature water required to avoid condensation on the beam systems.

A plate heat exchanger is installed on the high temperature system to allow a single operating low temperature chiller to produce high temperature water via the heat exchanger.

3.3.1 Primary Condenser Water System

The primary condenser water system comprises of 6 adiabatic coolers on an open level 13 roof deck. Each chiller will have a condenser water pump that circulates condenser water through the chiller condenser vessel and then through the adiabatic coolers.

The condenser water system is a closed system, as adiabatic coolers are being used.

Features of the design that assist in energy conservation are:

a) Leaving condenser water reset to achieve the most efficient chiller operation.

b) Cooler fan cycling.

3.3.2 Supplementary Condenser Cooling Water System

The supplementary condenser cooling water (SCCW) system provides heat rejection for communications/server rooms and lift motor room air conditioning.

Air conditioning systems for this type of application require continuous operation, and the provision of a SCCW system means that the chilled water system does not need to run on a continuous basis at very low load.

The SCCW utilises the adiabatic coolers described in section 3.3.1 for heat rejection.

3.4 Electrical Systems

3.4.1 General

Incoming electrical power is reticulated to switchboards located throughout the building.

The electrical services installation includes the following provisions:

a) Main incoming power supply

b) Main switchboard, distribution boards and low voltage reticulation

c) UPS distribution system

d) Lighting and power

e) External lighting

3.4.2 Incoming Electrical Supply

The incoming electrical supply to the building originates from the high voltage underground reticulation network of the local distribution company (Citipower).

The incoming high voltage supply will be transformed to 400/230 volt, 3 phase supply by a new authority owned substation constructed as the early works package, to serve the building.

3.4.3 The Main Electrical Switchboards

The main electrical switchboard is located in the main switchboard room at basement level 1 adjacent to the Citipower substation.

The main switchboard receives two Citipower supplies and provided with an automatic bus tie interlock arrangement to enable either Citipower supply for mains power to the whole of the electrical reticulation system. An automatic load shed control system will manage the load shed and bus tie changeover system to maximising the use of the available 'healthy' supply capacity. On restoration of the mains supply, the system will revert to 'normal mode' with each supply serving approximately half of the required electrical loading.

The main switchboards are purpose built for the project with AS3439 Form 4 construction.

3.4.4 Uninterruptible Power Supply (UPS)

A dedicated 160kVA solid state, battery backed up UPS (20 minutes) is provided for electrical systems to the building.

The UPS unit will be installed in an air conditioned space at roof plant (Level 13).

The electrical reticulation from the UPS unit will extend to DBs located at every third floor and in the B1 level for extension of sub-circuits to the BAS, the critical communications riser rooms and the like.

3.5 Lighting

The lighting selection for this building incorporates high efficiency elements whilst maintaining an architecturally sympathetic treatment of the internal spaces.

Location	Proposed System
Basement Level Theatre	Lowerable Compact fluorescent downlights. Additional lighting fixtures are provided in order to compensate for lamp failure between routine lamp servicing over summer break.
Basement Foyer	Down light fixtures to support architectural treatment of space – 'Rubic cube' style ceiling. Decorative wall washers behind foyer stairs.
Ground Floor – General	Linear fluorescent fixtures concealed within ceiling baffles. Selective concealed down lighting to highlight offset walls.
Level 1 General	Linear fluorescent fixtures concealed within ceiling baffles. Selective concealed down lighting to highlight offset walls.
Level 1 Lecture Theatre	Recessed linear fluorescent fixtures and downlights.
Level 2, 3, 5 & 6 Seminar and Tutorial Rooms and Teaching Labs	Low glare linear fluorescent fixtures with ceiling recessed wall washers for white board lighting.
Levels 7 to 12 Academic Offices	Low glare linear fluorescent fixtures recessed within ceiling elements. Day lighting sensors and perimeter dimming of fluorescent fixtures around perimeter circulation areas.
Feature lighting	Illumination of "Frit" by linear fluorescent fittings installed around the perimeter of the floors.

3.5.1 Lighting Controls/After-hour Operation

The lighting controls system provides the building users the opportunity to control the lighting in their area and provides automatic controls for energy management and time based operation. Suitable controls are provided to ensure Green Star targets to allow areas for area switching is achieved.

Within the teaching spaces, meeting rooms and lecture theatres, the lighting controls have been provided locally.

The lecture theatres controllers are capable of building interfaces with the audio visual lectern controller. Occupancy sensors provide automatic energy savings between lectures.

Local mains voltage switches have been provided for the back of house areas.

For front of house areas the lighting controls will be time based.

3.5.2 Security Lighting

Security circuits (24 hours) are included to provide adequate lighting for safe circulation around the building after hours.

3.5.3 Automatic blind operation and considerations

The blinds are designed to work in conjunction with the building heating and cooling systems. They are operated by light sensors located on the exterior of the building or by individual controls located on the perimeter columns that can be manually operated. The blinds cannot be touched as this will damage the mechanism. Staff and students are not to touch the blinds or to place furniture or other objects under the blinds.

3.6 Domestic Hot Water

Domestic hot water is reticulated to all required fixtures, fittings and equipment throughout the building via centralised plant located within the rooftop plant room. The plant incorporates two of Rheem 621-275 gas water storage units complete with inlet and outlet manifolds and valves.

The thermostat senses the temperature of the water in the tank, and when it drops below the set point, the primary pump is activated. The flow in turn starts the water heater which returns heated water to the tank. A safety valve on each tank ensures that the water tanks are not bursting due to excessive pressure.

Hot water reticulates from plant room down to basement and branch off each floor to serve the base building and retail tenant.

The circulation pump comprises two parallel installed inline pumps with automatic change over depending on time and fault. The circulation pump pumps hot water which cools down in times of stagnation and non-use from the branch lines in the building back to the hot water unit. Hot water is replaced in the branch lines and ensures hot water in each branch lines all time.

Thermostatic mixing valves are installed adjacent to each fixture outlet which provides hot water. The thermal shut-off capability ensures that the valve will deliver a rapid shutdown in the event of cold water failure and prevents any user from scaling.

The valves will also shut down in the event of hot water failure. The thermostatic mixing valves are supplied as standard with a temperature lock shield to prevent unauthorized changes to the hot water temperature.

Hot water circulating pumps provide constant hot water temperature of at least 60 degrees.
Isolation valves have been located throughout the system including at the top of every main dropper, every branch off the main dropper and at every group of fixtures

4 Transport Facilities

4.1 Cyclist Facilities

The bicycle storage for this building is located in a secured and weather protected area. The enclosed area is easily accessible from Berkley Street, and is within 35m of the building's main entrance.

23 bicycle racks have been provided, each rack can store 2 bikes. Therefore a total of 42 bicycle parking spaces are available. To provide amenities for the cyclists, 6 unisex toilet/showers have been provided and 8 lockers are located in each unisex toilet/shower.

4.2 Public Transport

The building is located in close proximity to a number of different public transport stops. Figure 3 below demonstrates the different facilities, this includes:

A: Tram Routes 1, 3, 5, 6, 8, 16, 64, 67, 72 on Swanston Street

B: Tram Routes 19, 57, 59 on Elizabeth Street

C: Tram Routes 19, 59 on Elizabeth Street

D: Tram Route 55 on Peel Street

In addition to this, Melbourne Central Train Station is located approximately 400m down Swanston Street, and is regularly assessable by any tram.

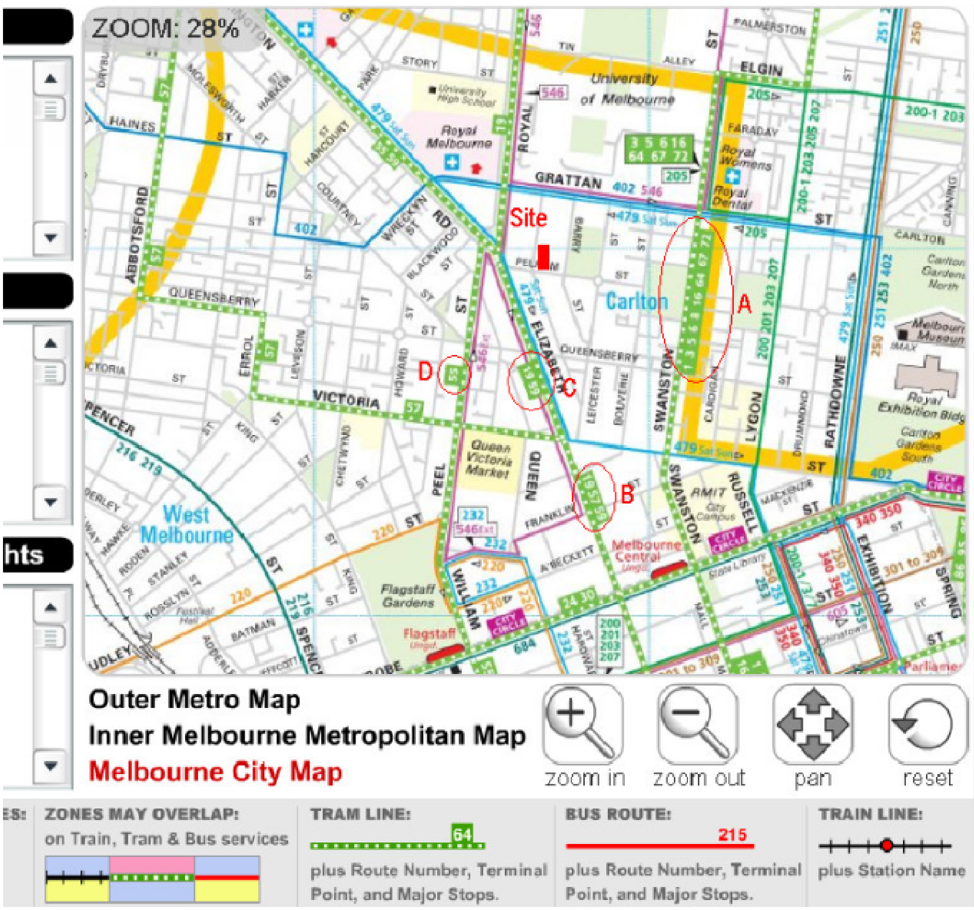

Figure 3: Proximity to Public Transport

5 Materials and Waste Policy

The waste bins that are to be utilised in the office areas at the E&C building consist of small desk top bins on every desk for landfill waste, colour coded red in accordance with Australian Standards and a mixed bin, colour coded yellow for mixed recyclables including glass, clean cardboard, newspaper, plastic, paper, aluminium, corrugated paper cups and milk containers.

It is expected that each individual is responsible for emptying this small red bin themselves into the designated waste bin in the kitchen or corridor areas. The yellow bins will be emptied daily by the cleaners.

In the kitchen and corridor area's there will be bins for landfill and mixed waste. Posters will be displayed in these areas informing the building occupants the Do's and Don'ts for the bins.

This approach assists in eliminating contamination of the recycled waste that is delivered to Visy, and will potentially see the volume of recycling increase.

For the latest updates and information relating to materials and waste at the University of Melbourne, refer to the following website:

http://www.pb.unimelb.edu.au/ehs/

6 Expansion/Re-fit Considerations

When undertaking expansion and/or re-fit to the current building it is important to consider the environmental aspects that were designed and incorporated in the project. These initiatives need to be conserved to maintain the environmental integrity of the building.

The Green Building Council of Australia's Green Star Education PILOT rating scheme provides an environmentally holistic system for the measurement of a building design. It aims to measure the environmental performance of buildings over a wide range of issues, including; water, energy, materials, indoor environmental quality, site considerations and emissions.

Green Star was created to:

- Establish a common language and standard of measurement for green buildings;
- Promote integrated, whole-building design;
- Recognise environmental leadership
- Identify building life-cycle impacts;
- Raise awareness of green building benefits; and
- Transform the built environment and reduce the environmental impact of the development.

The Green Star rating is on a 6 star rating scale, but the Green Building Council of Australia only recognises developments which achieve 4, 5 or 6 stars. A 4 star Green Star rating represents best practice placing a development within the top quartile of the industry. A 5 star building generally describes Australian Excellence in base building design whilst a 6 star building describes a World Leader in environmental building design.

6.1 Green Star Education PILOT Target Points

The Green Star points targeted to allow the building to achieve a 5 star rating are summarised in Appendix A. At a minimum any further expansion/refurbishments should incorporate the intent of these credits.

Points are targeted in the following categories with the main initiatives outlined;

- Management
- Indoor Environment Quality (IEQ)
- Energy
- Transport
- Water
- Materials
- Emissions

6.1.1 Management

6.1.1.1 Inclusion of Environmental Design Consultant

It is recommended that any future works should include the involvement of an Environmental Design Consultant in the project team. The Environmental design consultant should be familiar with the design principles of the building and will be able to consult to the project team and clients on items required to uphold the environmental integrity of the building.

6.1.1.2 Commissioning

Commissioning is a vital stage to any construction project. Without thorough commissioning a building rarely operates as originally designed and intended. Any future works should incorporate commissioning clauses, and should ensure that existing systems were not affected by the new works.

6.1.1.3 Building Users Guide & Learning Resources

This Building Users Guide should be regularly updated to include any changes and any future works. In addition to this touch screen information kiosks are located on every floor to show the environmental performance of the building. These should also be updated to reflect any changes to the building.

6.1.1.4 Environmental Management and Waste Management

To reduce the impact of any construction activities it is recommended that the contracted builder has an Environmental Management Plan which is ISO 14001 assured. In addition to this the builder should be contractually required to recycle at least 80% construction waste by weight.

6.1.1.5 Maintainability

Maintainability aspects should be considered when undertaking any future works to the building. The person responsible for the maintenance of the building should be consulted on the proposed design and asked to give advice on the maintainability aspects of both the building services and the external building features. The aim of this is to minimise the ongoing building maintenance throughout a building's lifecycle.

6.1.2 Indoor Environment Quality

6.1.2.1 Ventilation Rates

A 100% improvement on outside air rates was designed for the building. All future works should maintain this increase in outside air rates.

6.1.2.2 Air Change Effectiveness

All mechanical ventilation systems are to be designed to achieve an Air Change Effectiveness of >0.95 for at least 95% of the nominated area when measured in accordance with ASHRAE F25-1997. The air change effectiveness is to be measure in the breathing zone, 1m from the finished floor level.

All naturally ventilated systems are required to demonstrate the air distribution and laminar flow pattern for at least 90% of each space, in the direction of air flow for not lass then 95% of the standard hours of occupancy.

6.1.2.3 Carbon Dioxide and VOC-Monitoring and Control

A VOC Sensor is to be installed at each return air duct, the sensor is to be linked to the BAS, and is to allow continuous monitoring of the VOC pollutants in the space, it is to provide an alarm when the VOC pollutant levels reach 500μg/m^3 level.

Carbon Dioxide (CO_2) sensors are also to be provided at each return air duct of any mechanically ventilated and air conditioned system that has a return air component. The sensors shall provide monitoring and control of the carbon dioxide levels of the return air. If the CO_2 levels exceed 800ppm the sensors shall control the adjustments of the outside air ventilation rates to the respective zone.

6.1.2.4 Daylight & Daylight Glare Control
At least 30% of the UFA shall have a daylight factor of 2.5% when measured at the floor level under a uniform design sky. The measurements shall be consistent with the Green Star Requirements. In addition to this, to reduce glare automated blinds are to be installed on every window of the UFA to control all direct sunlight penetration. The automatic motorised blinds are to be controlled by sun sensors. There are already 12 of these sun sensors located on level 6 and level 11 and distributed across all four facades that can be used to control any new blinds that are to be installed due to any refurbishment.

6.1.2.5 High Frequency Ballasts
High frequency ballasts are to be installed in fluorescent luminaries for at least 95% of the UFA.

6.1.2.6 Thermal Comfort
Thermal comfort levels measured using the Predicted Mean Vote (PMV) levels for the design and as-built design of the UFA are to be between -1 and +1. The PMV levels are to calculated in accordance with ISO7730 (or equivalent using Draft ASHRAE Comfort Standard 55 and 'Developing an Adaptive Model of Thermal Comfort and Preference - Final Report on ASHRAE RP884') and must be achieved during Standard Hours of Occupancy and using standard clothing, metabolic rate and air velocity values (as nominated in the Green Star Manual) for 98% of the year.

In addition to this, every enclosed office that has no more than four workstations is to be provided with user-control of air supply rates, air temperature or radiant temperature. All office areas with more than four workstations must have individual control of air supply rates, air temperature or radiant temperature for every 4 work station.

6.1.2.7 Volatile Organic Compounds & Formaldehyde Minimisation
Various finishes and coverings are to meet the benchmarks for low Volatile Organic Compound (VOC) content or emissions and formaldehyde emission levels, including:

- 95% of all paint are to be low-VOC emitting (per EN 13419);
- 95% of all carpets and other floor finishes are low-VOC (carpet - US Carpet and Rug Institute Green Label; other floor finishes - EN 13419) OR no carpet and floor finishes are to be installed;
- 95% of all adhesives and sealants are low-VOC (per EN 13419) OR no adhesives/sealants are used;
- 95% of all tables, chairs, and desks are low-VOC (per US EPA's Environmental Technology Verification test method or California specification 01350 15 July 2004. Refer to the Submission Guidelines for emissions standards); and
- All composite wood products that are used, including joinery and loose furniture, are to be low emission formaldehyde (rated E0) or no composite wood product is used.

6.1.3 Energy

6.1.3.1 Energy Improvement
When undertaking any changes to building design, energy efficiency and energy efficient designs must be considered. The current building design achieves at least a 25% reduction in energy when compared to a standard university building design. It is recommended that this be proved in any major refurbishments when using the Green Star Energy Calculator.

In addition to this any equipment/appliances purchased, should have at least a 4 Star Energy Rating.

6.1.3.2 Unoccupied Areas
Each separate mechanically ventilated enclosed space within the UFA (e.g. laboratory, classroom, tutorial space, lecture theatre) is to be designed to be automatically shut down or the temperature set-back (air-conditioning) when not in use.

6.1.3.3 Lighting Zoning and Control
All individual or enclosed spaces are to have individual switches. In addition to this, the sizes of individually switched zones are not to exceed 100m^2. All switching is to be clearly labelled and located in a position which is easily accessible by the building occupant. Automated lighting control, including occupant detection and daylight adjustment, are also to be provided.

6.1.3.4 Efficient External Lighting
All External lighting and outbuilding lighting it to have an efficacy of at least 50 lumens/watt (examples include high- and low-pressure sodium, metal halide, induction lighting, tubular and compact fluorescent).

95% of the outdoor spaces are not to exceed the minimum requirements of AS 1158 for illuminance levels by more than 50% and 95% of external lights are to have daylight sensors, these can be combined with a time switch.

6.1.4 Transport

6.1.4.1 Cyclist Facilities
If the extensions and/or refurbishment result in additional staff using the building, additional cyclist facilities should be added such that a bicycle storage space is provided for at least 10% of building staff, in addition to this accessible showers are to be provided for every 10 bicycle spaces, and lockers are to be provided for every bicycle space provided.

6.1.5 Water

6.1.5.1 Occupant Amenity Potable Water Efficiency
Efficient water fixtures are to be provided for any extensions and or refurbishments. All refurbishments and/or extensions shall keep in track with the existing building design including utilisation of the blackwater treatment plant for non-potable uses including toilet flushing and heat rejection make-up water.

6.1.5.2 Water Meters
Water meters are to be installed for all new major water uses (e.g. laboratories, cooling towers, irrigation, rainwater, bathrooms, and hot water). Meters must be electronic and/or linked to a Building Management System to provide a leak detection system.

6.1.5.3 Heat Rejection Water Consumption
If any additional heat rejection plant is required due to refurbishment/extension these should be closed circuit heat rejection such as the installed Muller 3C or other such technology. The heat rejection should also utilise the black-water to wet the pre-cooling pads.

6.1.5.4 Fire System Water Consumption
Not applicable to refurbishments

6.1.6 Materials

6.1.6.1 Flooring
All flooring used in the project is to have a reduced environmental impact. The product selection should examine the resource utilisation of the flooring material (eco-preferred content and durability), the management procedures of the flooring supplier (including the EMS and Product stewardship) and the reusability of the material (i.e. modular and/or designed for disassembly). The Green Star Flooring Calculator should be used as a basis for the flooring selection.

6.1.6.2 Joinery
At least 95% of all joinery (by area) that is used in the refurbishment/extension is to be either new and has been designed to be modular AND is easily disassembled for future reuse; or is to be made from salvaged, refurbished or reused materials.

6.1.6.3 Loose Furniture

All loose furniture (defined as chairs, tables and storage only) used in the project has a reduced environmental impact. The product selection should examine the resource utilisation of the furniture material (eco-preferred content and durability), the management procedures of the flooring supplier (including the EMS and Product stewardship) and the reusability of the material (designed for disassembly). The Green Star Loose Furniture Calculator should be used as a basis for the flooring selection.

6.1.7 Emissions

6.1.7.1 Ozone Depleting Potential of Refrigerants

All HVAC refrigerants in use are to have an Ozone Depletion Potential (ODP) of zero and all specified thermal insulation in the building is to avoid the use of ozone depleting substances in both it's manufacture and composition.

6.1.7.2 Light Pollution

No light beams are to directed beyond the site boundaries or upwards without falling directly on a surface with the explicit purpose of illuminating that surface and where the design complies with AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting.

7 References and Further Information

Further information can be found in the following websites:

Energy

Victorian Energy and Greenhouse Management Toolkit
http://www.seav.vic.gov.au/advice/business/EGMToolkit.html

NABERS Energy Rating
http://www.nabers.com.au

Waste

EcoRecycle Victoria:

http://www.ecorecycle.vic.gov.au

Department of Environment and Conservation Resource NSW

http://www.resource.nsw.gov.au/index-RNSW.htm

Water

http://www.savewater.com

Materials

http://www.ecospecifier.org

Tenancy Guidelines

Queensland Government - Ecologically Sustainable Office Fitout Guideline

http://www.build.qld.gov.au

Green Building Council Australia – Clean Up Your Business

http://www.gbcaus.org

APPENDIX A – GREEN STAR CREDITS TARGETED IN DESIGN

Management	
	Green Star Accredited Professional
	Commissioning - Clauses
	Commissioning - Building Tuning
	Commissioning - Commissioning Agent
	Building Users' Guide
	Environmental Management
	Waste Management
	Learning Resource
	Maintainability
Indoor Environment Quality	
	Ventilation Rates
	Air Change Effectiveness
	Carbon Dioxide and VOC Monitoring and Control
	Daylight
	Daylight Glare Control
	High Frequency Ballasts
	Thermal Comfort
	Internal Noise Levels
	Volatile Organic Compounds
	Formaldehyde Minimisation
	Mould Prevention
Energy	
	Energy Improvement
	Unoccupied Areas
	Lighting Zoning and Control
	Efficient External Lighting
Transport	
	Cyclist Facilities
	Commuting Mass Transport
	Pedestrian Routes
Water	
	Occupant Amenity Potable Water Efficiency
	Water Meters
	Heat Rejection Water Consumption
	Fire System Water Consumption
Materials	
	Recycling Waste Storage
	Recycled Content of Concrete
	Flooring
	Joinery
	Loose Furniture
Land Use & Ecology	
	Reuse of Land
	Change of Ecological Value
Emissions	
	Ozone Depletion Potential
	Refrigerant Leak Detection and Recovery
	Reduced Flow to Sewer
	Light Pollution