



OVERVIEW OF THE 60L GREEN BUILDING

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INTRODUCTION

60L is the premier green commercial building in Australia, unique in its approach to energy and water consumption, and the use of recycled and re-used materials during construction.

60L shows how we can achieve a commercially viable, healthy, low energy, resource-efficient workplace with minimal impact on the environment.

PROJECT PARTNERS

The developers of 60L are the Green Building Partnership.

The Green Building Partnership is a collaboration of two ethical investment companies - Surrowee Pty Ltd and Green Projects Pty Ltd.

The companies came together to design and develop the 60L building with Green Projects Pty Ltd being set up specifically for this building project.

Both partners share the same environmental and investment philosophies, and identified the need for a green or sustainable commercial development in Melbourne.

The 60L building is intended to 'set the bar' of what can be achieved using environmentally sustainable principles, within the financial boundaries of a commercial development.

The partners wanted to extend the ideas that have been implemented in residential developments and take a holistic environmental approach to commercial development - a highly competitive area where environmental considerations have not traditionally been given a high priority.

60L Project stakeholders

The 60L project is the result of the contributions of a great many people and organisations. Our particular thanks go to:

Advanced Environmental Concepts	Che Wall
Australian Conservation Foundation	Don Henry & Michael Krockenberger
Donald Cant Watts Corke	Tim Hogg

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& Ben Jordan
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Wilmot
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Peter Brotherton & Alan Pears
Perry Lethlean
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1. Building Design and Materials

60L was designed to minimise its impact on the environment: the building structure, choice of materials; location and physical orientation; the methods to be used by the builders; the way the building would function once completed - all these were considered through the 'lens' of sustainable environmental practice.

The general principles adopted for the 60L Green Building were to:

- Create a quality building that is commercially viable;
- Minimise the consumption of materials and maximise their reuse;
- Protect the natural environment by astute selection and use of materials; w
Minimise energy consumption and greenhouse gas emissions;
- Minimise the consumption of mains water and maximise recycling of treated wastewater, and
- Adopt environmentally sound and healthy work practices, during both construction and occupancy.

Instead of being a side issue, environmental design, energy and resource use became the critical focus of the building design.



Building for sustainability

60L is different. It breathes.

There are exposed brickwork walls which are a feature instead of something to be hidden. The bricks are either originals or have been recycled, and cleaned without the use of acids.

In many buildings, all of the wiring and pipes are neatly hidden, which may look nice and sterile, but is incredibly wasteful as it effectively puts a blanket between the building mass (floors and ceilings), trapping heat which then has to be removed by expensive air-conditioning.

At 60L there is an aesthetically pleasing interplay of ceiling tiles and exposed areas which creates an intriguing pattern.

Some of the beautiful hardwood door frames are so obviously recycled there are still old nail holes. They have been left that way to remind people that old, reused materials can look every bit as fine as the new.

The extensive application of reused and recycled materials created one difficulty which was not entirely foreseen at the outset. That is, how could we explain to tradespeople and builders what was an acceptable level of 'finish'?

For example, should we paint black pipes white? Should we use metal angle pieces in corner plaster work? A host of small detail specifications turned out to be necessary throughout the building process to help tradespeople used to working with today's energy- and waste-intensive construction methods adapt their way of working.





This lesson was very important to us - involve as many people who will be undertaking the building task as early as possible, and specify as clearly as possible.

It's not that you are asking people to do something environmental. You are asking people to do something different.

TECHNOLOGY & CONSTRUCTION

60L uses *appropriate* technology, rather than leading edge technology for the sake of it. By 'appropriate', we mean those solutions which balance energy and resource use minimisation with the best outcome for building occupants.

Thus, the sewerage and water systems are the most advanced currently available. But in areas where traditional materials and processes match the designer's purpose, these are used in preference.

For example, chrome products have a hard, shiny, aesthetically pleasing look. But they are energy intensive and produce more toxic residues in production than stainless steel. So, if you visit 60L you will see virtually no chrome but plenty of stainless steel - brushed, buffed and equally pleasing to the eye.



Technology and systems

The subtlety of 60L's construction lie in the systems which have been developed to ensure the finished building operates as an interdependent whole, rather than as a number of discreet and unconnected sub-systems.



For example, we had made a choice to tackle a difficult building project rather than a simple one on the basis that this was intended to raise the bar on what was possible in sustainable building. This meant avoiding the entire destruction of the old building on site and the subsequent waste of its materials. Ordinarily, old brickwork would be dismantled and shipped off to a reclaiming site where the bricks would be cleaned with toxic chemicals. At 60L we designed an on site system for cleaning that used no chemicals - from dismantling right through to when the bricks were used in new site walls.

Sourcing concrete was another technology issue that called for a systemic approach. In Australia, commercial buildings are rarely constructed with recycled concrete due to a range of concerns mainly to do with finish and wear. Sixty percent of the concrete in 60L is composed of recycled aggregate. What allowed us to achieve this result was a sophisticated research process that fed into the building design early on, which meant that by the time it came to pour, we knew all there was to know about the technical characteristics of the product we were using.



MATERIALS USED

60L uses a range of solutions:

- The original building on the site was not bulldozed but was partially dismantled so that existing materials could be re-used. Timber floor joists and planking were re-used, as were bricks, glazed partitions and most of the old building structure, as well as the heritage listed facade.
- Concrete poured at 60L was made using a 60% recycled aggregate (in this case, crushed concrete reclaimed from other buildings).
- Timber windows and door frames were fabricated from recycled materials, as are other items such as reinforcing steel and carpets (recycled synthetics).
- Most glues, adhesives, sealants and fillers commonly used in buildings give off highly toxic gases. Use of these was minimised wherever practicable.
- 60L uses about 50% less PVC than a typical commercial building of the same size and use. PVC was eliminated from all water & wastewater pipes, electrical conduits and light fittings.
- Where new materials had to be used, preference was given to recycled and recyclable products such as bricks, timber, steel and copper.

It is important to recognise that 60L uses *appropriate* technology, rather than leading edge technology for the sake of it.

CONCRETE CHOICES AND SPECS

The concrete used in 60L is composed of 60% recycled aggregate (crushed concrete reclaimed from other building sites).

Uses for this product in the 60L project include:

- floors;
- beams and supports;
- columns.



BRICKWORK – CHOICES AND SPECS

No new bricks were purchased for the construction of 60L. All brickwork on the site is either original, or constructed from reclaimed bricks which were part of the original building on the site, parts of which were dismantled.

Reclaimed bricks were cleaned at the 60L site, without the use of bleach, acid or other toxic materials.

The mortar used is a standard brickies mortar mix.

After construction, new walls were cleaned with water and biodegradable detergent only. No acid or bleach was used in the clean-up.





STEEL AND OTHER METALS

Throughout the building a range of steel and metal products are used.

Wherever possible these were reclaimed or recycled. When products were purchased new - such as screens, grates, fittings and smaller items - the lowest embodied energy choice was made. The building presents many stylish and interesting views which are made so through the use of everyday materials in unusual situations.

The stunning glass-roofed atrium was constructed using recycled steel beams





Metal pipes

Copper was used wherever possible, for example in refrigerant systems, as it is a fully recyclable material.

Stainless steel

Smaller components such as shower drains, door and window fittings, nuts and bolts and finishing elements were made from stainless steel rather than chrome-plated steel because of their lower embodied energy.

Partitions and screens

Like any commercial building, 60L has many interior walls and screens. These were made from recycled steel products, some of which are traditionally ignored when it comes to commercial building design, or which are seen as having a narrow scope of application.

PLASTICS

A typical commercial building uses PVC (polyvinyl chloride) for water pipes, electrical conduits, electrical insulation and a variety of other purposes.

60L has only about 50% of the PVC content found in a typical commercial building of this size and purpose. This was achieved through a combination of early specification, negotiation and discussion with suppliers.

Where PVC had to be used was mainly in protective sheathing for electrical cabling.

Also, use of silicon sealants, fixers and adhesives, composed of highly volatile chemicals, was minimised during construction.



▲ Copper was used in preference to plastic wherever possible

▲ Electrical conduit was procured with no damaging PVC insulation covering

▲ Service pipes are made of unpainted recyclable plastic.

TIMBER PRODUCTS

60L has a mixture of reclaimed, recycled and new timber products.

A great deal of timber flooring (century-old redgum that has many years of wear in it yet) was reclaimed from the original building on site. This was cleaned and prepared by hand at the site. The end product has been reused as flooring in the main atrium area. Using natural oils, this flooring is one of the main building features. As visitors enter, they see a glowing, rich, red expanse of burnished timber.

Recycled wood garnered from other building sites and recycling specialists was used in wood frames and door frames. In some of this timber, the original nail holes are still visible - we instructed the tradespeople to avoid using commercial woodfillers based on volatile oils.

Where new wood products were procured, they were sourced from pine plantations.



Finishes on the timber are all natural oils rather than polyurethane paints. It was another important detail of the design and construction that 60L was intended to be tactile - a place where people came and were able to touch the surfaces and feel different sensations.



▲ Aged timber was reclaimed on site



▲ Timber finishes use natural oils

▲ Century-old nail holes are still visible



CHEMICAL PRODUCTS

Modern construction methods - both commercial and housing depend greatly on the use of chemicals to clean, glue, prepare, fill, treat, paint and finish the surfaces we inhabit.

60L has been designed to limit the use of these at all stages - in construction, during fit-out and when the building is inhabited.

We believe that constant exposure to chemicals is a major contributor to so called 'sick building' syndrome. At the moment, the jury is still out when it comes to incontrovertible evidence that exposure to chemicals permanently damages health. However, when we designed 60L, a concept known as the Precautionary Principle was in the forefront of our thinking.

The Precautionary Principle is a well-established environmental principle which argues that if we wait until 'beyond-doubt' proofs are established it will be too late. Global climate change is not proven beyond all doubt, but that doesn't mean we shouldn't be acting right now to reduce greenhouse gas emissions.

Especially when all it takes is a little thought and planning.

Outgassing

'Outgassing' is a well-established problem with many chemical and highly processed building products.

For example, significant quantities of formaldehyde are used in the manufacture of chipboard products (compressed wood) that are frequently used in furniture. Formaldehyde is a noxious chemical. As the furniture ages, the formaldehyde leaches out of the original material and into the office atmosphere where we breathe it.

Laminates are also used extensively. These are glued to surfaces using extremely volatile products which again, leach their poisons into the atmosphere at work.



AN OASIS IN THE CITY DESERT

The 60L rooftop garden provides building tenants with a space where they can relax and enjoy what passes for the great outdoors in a city as large as Melbourne.

The north-facing garden is designed to make best use of sun and prevailing wind patterns. It is planted with species of native shrubs and flowers.

The garden is designed to use recycled water processed by the building's water reclamation system.

It also acts as a source of thermal mass, insulating the offices below and providing an offset to heat build-up.





2. HEATING, COOLING AND VENTILATION

60L features a clever natural ventilation system that cuts down on the need for artificial heating and cooling without using any sophisticated technology.

The design includes a large central atrium which allows air to flow across tenancies from the light wells and into the atrium from where it is then vented to the atmosphere through four thermal chimneys.

The system is linked to computer controlled louvre windows in all tenancies and louvres on the chimneys which operate according to wind speed & direction to optimise natural air flows through the building. The air system allows automatic cool air purging at night to eliminate the heat build-up from hot summer days.

Tenants can also control air flows through openable windows & louvres in the office areas. When outside temperatures exceed the parameters of the fresh air system, tenancies have small domestic-sized, reverse-cycle air conditioners.

Care has been taken during construction to minimise the use of materials that release volatile organic chemicals such as glues, adhesives, sealants, and organic solvent-based paints.



▲ 60L's thermal chimneys are both an energy saving innovation and a startling architectural element.





60L GREEN BUILDING

60L air systems

The approach of the design team was to maximise the use of passive design techniques and then to add the required active systems necessary to achieve all-year round comfort for the occupants of a commercial office building.



The building design considered four interrelated aspects:

- daylight - maximising the natural light available to tenants;
- natural ventilation - maximising the use of natural systems rather than blocking out the natural world and then use air-conditioning technology to replicate it.
- comfort - providing a combination of acceptable temperature and airflow in order to provide a healthy and productive workplace which maximises the potential productivity of its inhabitants.
- demand management - offices are rarely fully occupied all of the time, and not all areas require an optimum comfort environment. Also office equipment can be operated so as to minimise energy consumption and heat generation. By managing the demand for lighting and air-conditioning, the size of the systems required and the extent to which they need to be operated can be reduced.



Providing access to daylight reduces the need for artificial lighting, thereby reducing the heat generated by lights, and reducing the need for cooling of the office environment to achieve a comfortable working environment.





60L
GREEN
BUILDING

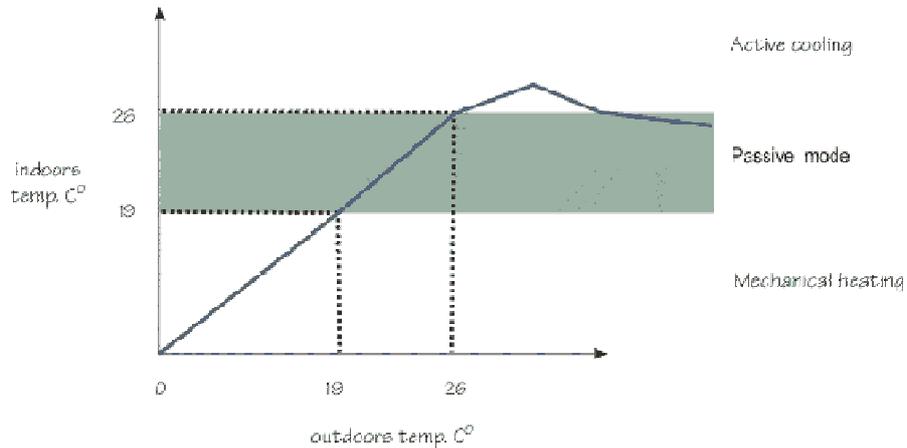
VENTILATION AND HEATING/COOLING – TECHNOLOGY AND OPERATING MODES

Operating modes

60L's designers have challenged traditional thinking by assuming that personal comfort is NOT a fixed point, such as 20C, but instead covers a band from 19-26C.

So long as temperature is held within this band, people can achieve comfort by adjusting windows and putting on, or taking off jackets and jumpers.

The 60L green building has two operating modes: passive - when the internal temperature is between 19-26C air flow is controlled by the computerised louvre system and by tenants opening or closing windows accordingly; active - when the building temperature is above or below the 19-26C band, active heating or cooling can be operated by tenants.



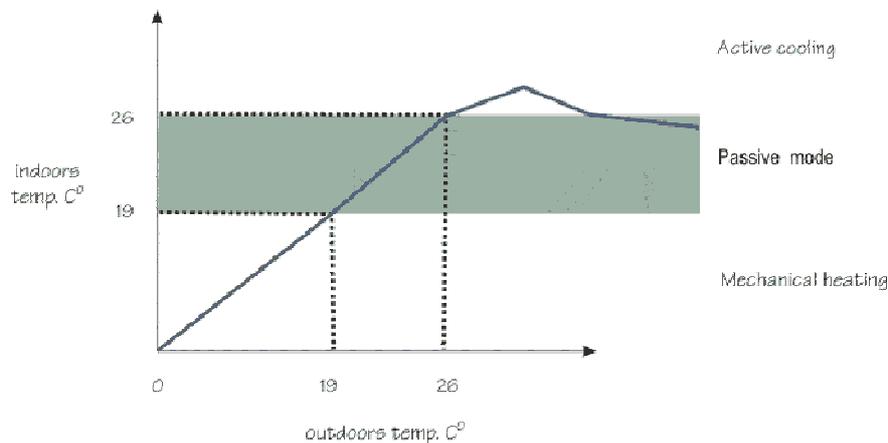
Outside temp.	Inside temp.	Building operating scenarios
below 19C	below 19C	60L's BAS system will close vents and louvres, allowing tenants to operate internal reverse-cycle air-conditioners to achieve personal comfort in each office.
between 19-26 C	below 19C	Louvres and vents are opened to allow the building to warm up to between 19-26C. Mechanical fans in the vent system may be used to pump warm air into the building to raise temperature faster than would otherwise occur through natural ventilation.
above 26C	between 19-26C	Louvres and vents are opened to allow the building to warm up to between 19-26C.
above 26C	above 26C	Louvres and vents are closed by the Building Automation system, allowing tenants to operate internal reverse-cycle air-conditioners to achieve personal comfort in each office.



VENTILATION AND HEATING/COOLING – MATERIALS AND COMPONENTS

Depending on weather, tenant comfort within the building is achieved through either passive or active ventilation, heating & cooling systems.

- **passive** systems are centred around the light wells, air vents, openable windows in all tenancies and automated louvre controls. The atrium functions as the lungs of the building, providing a central space which allows air to flow in and out of the building core. The open plan office arrangements mean that air flows through both the public and tenant areas of the building;
- an **active** system consisting of a central ducted fresh air supply with domestic-type split-system, reverse cycle air-conditioning units placed in the tenancies. The ducted fresh air supply is managed by a fan system, regulated by the computerised Building Automation System (BAS). A rooftop weather station feeds data to the BAS. Within the tenancies, occupants can control comfort through the use of individual air conditioners that can be operated whenever the internal temperature is outside the comfort range of 19-26 degrees celsius.





Ventilation and air conditioning components

There are six light wells on the building perimeter, each fitted with motorised louvres controlled through the building automation system (BAS) and plenty of manually opening windows & louvres.

On the roof, four thermal chimneys are equipped with BAS-controlled louvres. The louvres, placed on each side of the chimneys can be operated so as to take advantage of prevailing wind conditions and draw air from the atrium, improving circulation of fresh air throughout the building.

At night, the BAS system will operate the thermal chimney louvres to purge heat build-up that has accumulated during the day, and to reduce the building's thermal mass.

Louvre and window frames (constructed from recycled timbers) provide control of air flow to suit different weather and times of the day when the building is in passive ventilation mode.

A rooftop weather station monitors external conditions and is linked to the BAS so that internal comfort can be maximised by adjusting the amount of air allowed to enter the building.

The glass-roofed atrium is constructed of low emission glazing and is augmented by electronically-





60L
GREEN
BUILDING

controlled blinds which are opened or closed depending on the need to maintain or release heat build-up in the atrium.



BAS control system

The components of the HVAC system are controlled by 60L's building automation system.

The BAS gathers data through internal sensors which measure light, temperature, humidity and a range of criteria relevant to human comfort.

The BAS also provides on-line information to tenants to enable them to proactively manage their energy consumption and greenhouse gas emissions.



▼ all tenancies have split-system reverse cycle airconditioning units to augment the building comfort control systems.



▲ inlet conduits take outside air into the core of the building

▲ all tenancies have openable windows



Hierarchy of design elements in the HVAC system at 60L

Following is a list of the steps taken to provide fresh air, lighting, and thermal comfort to the building. The savings are cumulative design projections. That is, each one is a percentage saving over the previous improvement.

1. Reduce installed loads

Use of high efficiency light fixtures, office equipment, and designing for a lower occupant density, the internal thermal load of the 60L Building is reduced 53% over typical office space in Melbourne:

	60L Building	"Typical" office space
Lighting	7W/m2	20W/m2
Office equipment	5W/m2	15W/m2
Occupancy	1 person per 12sq.m.	1 person per 10 sq.m

Note that the occupant density assumes 60% of spaces are in use at any one time. Making use of office equipment power saving features and establishing sound efficiency practices amongst tenants (good demand management) will be essential to realising the lower load of the building design.

2. Widen the thermal control band

Typical office specification for heating and air conditioning requires inside temperature control between 21° and 24° and is almost always achieved by mechanical means. The 60L building has been designed to operate between internal temperatures of 19° and 26°. This reduces heating and cooling energy use by 41% over the previous design case by using natural, fresh air ventilation when the outside temperature is between 19° and 26°. Active, mechanical systems are only used when the outside air temperature is outside the target range.

3. Use daylighting

In addition to reduced peak load outlined in item one, encouraging daylight to enter the space reduces the electricity consumption for artificial lighting 52% below the (already lower) demand management savings identified above. Light shelves, central atrium and



light wells on the building north and south perimeter allow natural daylight into the building. Further savings are realised because the reduced internal load does not have to be removed by mechanical air conditioning plant. Both the size of the plant and the length of operation are reduced.



4. Natural ventilation

Natural Ventilation builds on the previous strategies that are used to reduce the internal thermal load. Exposing internal thermal mass (bricks and concrete surfaces) to the habitable space provides a thermal store and lower radiant surface temperatures. A little over 50% of the ceilings are exposed for this purpose. The use of 'night purge' when the overnight outside air temperature is below 24° to cool the building structure reduces the need for mechanical (active) cooling during the next day. The building makes use of both the stack effect (hot air rises) in thermal chimneys, as well as wind induced ventilation. The building control system either opens the ventilation louvres when the outside air is between 19° and 26° or activates the fans depending on the outside conditions. (see section below on control strategies) This natural ventilation strategy reduces energy consumption 23% over the 'typical' commercial building base case.

5. Solar shading

Shading is provided for the atrium roof and some windows in the summer as well as the use of glass which cuts down on the thermal gain from solar energy while still letting in most of the natural light.

6. Daytime natural ventilation

The occupants will be able to control some ventilation louvres and open some windows during the daytime to suit their personal taste. When the outside temperature exceeds 26° or is less than 19°, the building control system will close the louvres it controls and



drive the ventilation system. 7. Low E double glazing Double glazing and the use of 'low E' window coatings primarily reduce the heating load in the winter. This type of glazing also causes the inside surface of the window to be closer to the internal air temperature thereby improving the radiant temperature felt by the occupant. That is, it is more comfortable to sit near one of these windows.





AIR CONDITIONING

Approach

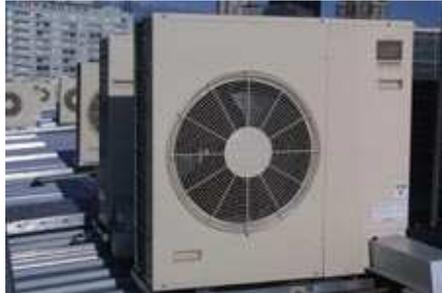
In a traditional office building, people do not have a lot of choice about whether to open a window, remove a jumper or put an extra layer on.

60L is intended to be a work environment where people have choice and responsibility about what happens at work.

Accordingly, the building designers took an approach based on several assumptions:

- the traditional concept of a single temperature point representing optimum comfort for all people and conditions be abandoned in favour of a widened comfort band ranging between 19-26 degrees celsius;
- a mix of complex and simple technologies could be brought to bear on the task of providing fresh, clean air and comfortable working conditions. These included the use of light wells and thermal chimneys using fairly simple louvre-type control systems, coupled with a computerised monitoring system that operated the various passive features to achieve the best mix;
- when the outside conditions meant the building could not be operated within the preferred comfort band (i.e. it becomes either hotter than 26 degrees or cooler than 19 degrees inside 60L), individual tenants would have the opportunity and choice of managing their own comfort.

Through this regime, tenants can manage their own use of air-conditioning in response to their own needs. Similarly, they are responsible for the cost of the energy they use and the greenhouse emission performance of their particular work area.



rooftop units power individual tenancy air-conditioning

Components

There are about 50 split system reverse-cycle air-conditioning units placed throughout the tenancy areas of 60L in a zoned configuration (is there a map of how this is intended to work).



the delivery unit in each tenancy is a slightly larger version of a domestic system.

The units are similar to domestic-type units.

The refrigerant used was chosen for its low ozone-depleting characteristics.

Manufacturer	need information
Model	need information
Rating	need information
Refrigerant	need information

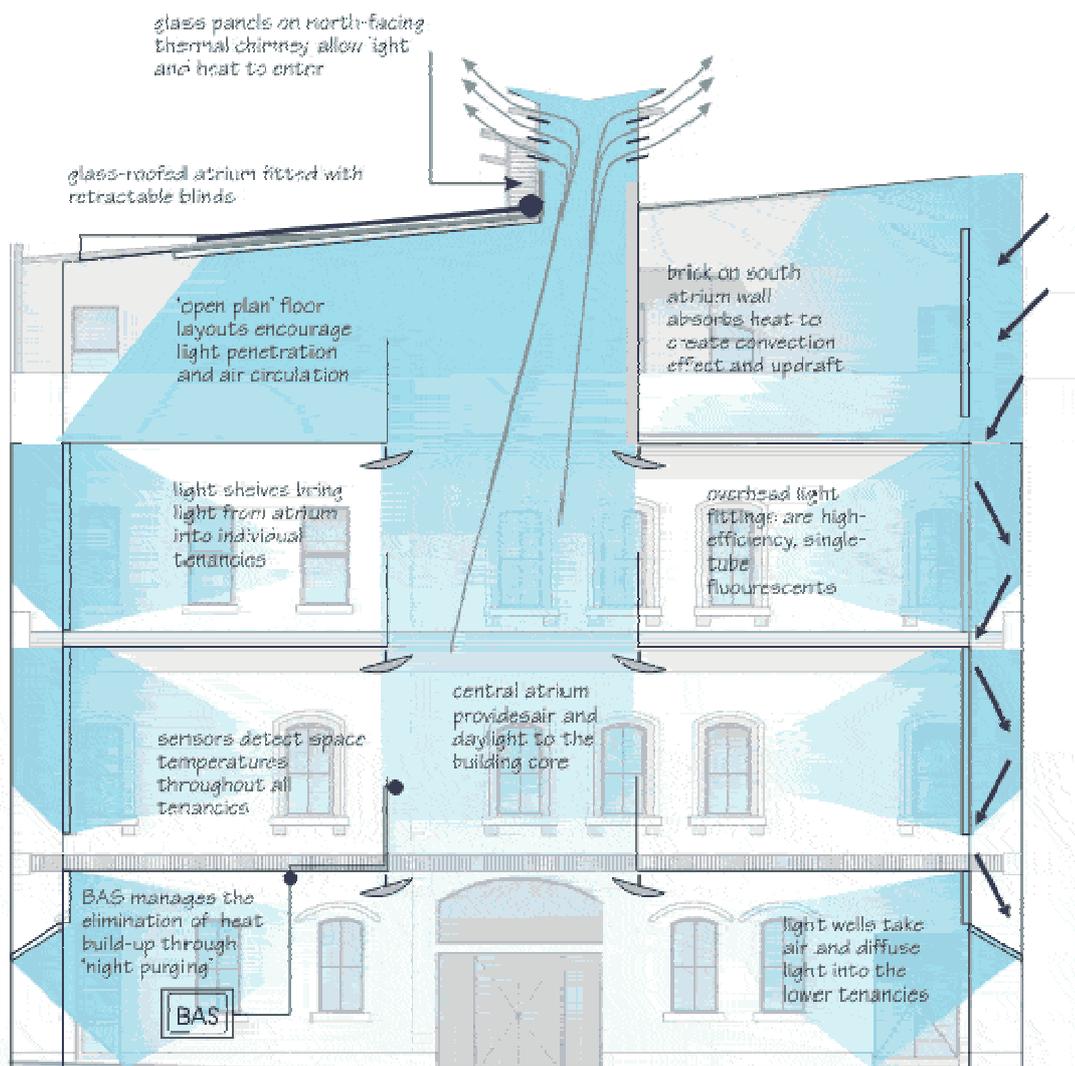
The plumbing used for the units is copper piping.



60L ATRIUM

The Atrium of 60L is designed with several purposes in mind:

- provide light and air to the building core and office areas which do not receive direct sunlight;
- air is drawn in through louvres fitted to the lightwells on the building perimeter and via the many openable windows in tenancies;
- air flows out of the building through the rooftop thermal chimneys as a result of a convection effect created by the atrium;
- intentionally to increase the public space within the building.





Components

The components of the atrium air circulation system are:

- six lightwells equipped with BAS controlled louvre windows bring air into the building;
- openable windows (constructed of recycled timber) in all tenancies;
- optional ducted fresh air can also be brought into the building via a rooftop mechanical fan system (variable speed drive);
- glass roof with hardened low-emission glass and mechanical blinds allows light and heat to enter the building in a managed way, so as to create a convection effect;
- four roof-mounted thermal chimneys situated in the building core at the south side of the atrium draw air up and out of the building. The thermal chimneys are equipped with BAS-operated louvres on all sides. They have a north-facing glass feature, together with a south-facing brick wall, so that light and heat enter the chimney (from the north), which warms up the brick wall, creating an updraft of warm air flowing up the chimney and out of the building.



▲ atrium allows light and heat into the building core



▲ louvres on thermal chimneys are controlled by Building Automation System (BAS)



▲ north-facing glass panels on thermal chimneys create convection that draws air up and out of the building



TENANTS' COMFORT

The ideas used to create the 60L heating, ventilation and air conditioning (HVAC) system offer surprisingly simple alternatives in creating comfortable thermal environments.

The building design considered four interrelated aspects :

- daylight - maximising the natural light available to tenants;
- natural ventilation - maximising the use of natural systems rather than blocking out the natural world and then use air-conditioning technology to replicate it.
- comfort - providing a combination of acceptable temperature and airflow in order to provide a healthy and productive workplace which maximises the potential productivity of its inhabitants.
- demand management - offices are rarely fully occupied all of the time, and not all areas require an optimum comfort environment. Also office equipment can be operated so as to minimise energy consumption and heat generation. By managing the demand for air-conditioning, the size of the systems required and the extent to which they need to be operated can be reduced.

In keeping with the designer's intention of reducing energy consumption and greenhouse gas emissions, it was decided to encourage 60L occupants to be responsible for their own energy usage and greenhouse emissions.

Comfort - what is it anyway?

The wide comfort band under which 60L operates in its passive mode (i.e. between 19-26 degrees celsius) is possible because the designers have chosen to interpret comfort as a relatively complex issue that varies from person to person, rather than the one-size-fits-all notion of comfort that is used in traditional office blocks.

The 60L designers have assumed that people are both clever enough and motivated enough to open or shut a window in order to maintain their comfort levels. Similarly, that they will, without too much ill grace, put on a jacket if they feel too cold or remove it if they feel too warm.

Also, the added component of circulating fresh air is a factor that enhances the comfort band. For example, at 26 degrees celsius, a gentle breeze effectively reduces people's perception of heat by approximately four degrees.



When the building is operating in its **passive mode**, occupants can adjust their comfort by opening windows or closing them. In passive mode, the operation of louvres and air-conditioners is fixed by the BAS: louvres can be adjusted by the main computer in response to the difference between internal and external conditions, air-conditioners cannot be operated.

When the building is being actively heated or cooled (i.e. outside the 19-26 comfort band) individual air-conditioners in the tenancies can be operated to enhance comfort.



LIGHTWELLS, THERMAL CHIMNEYS AND LOUVRES

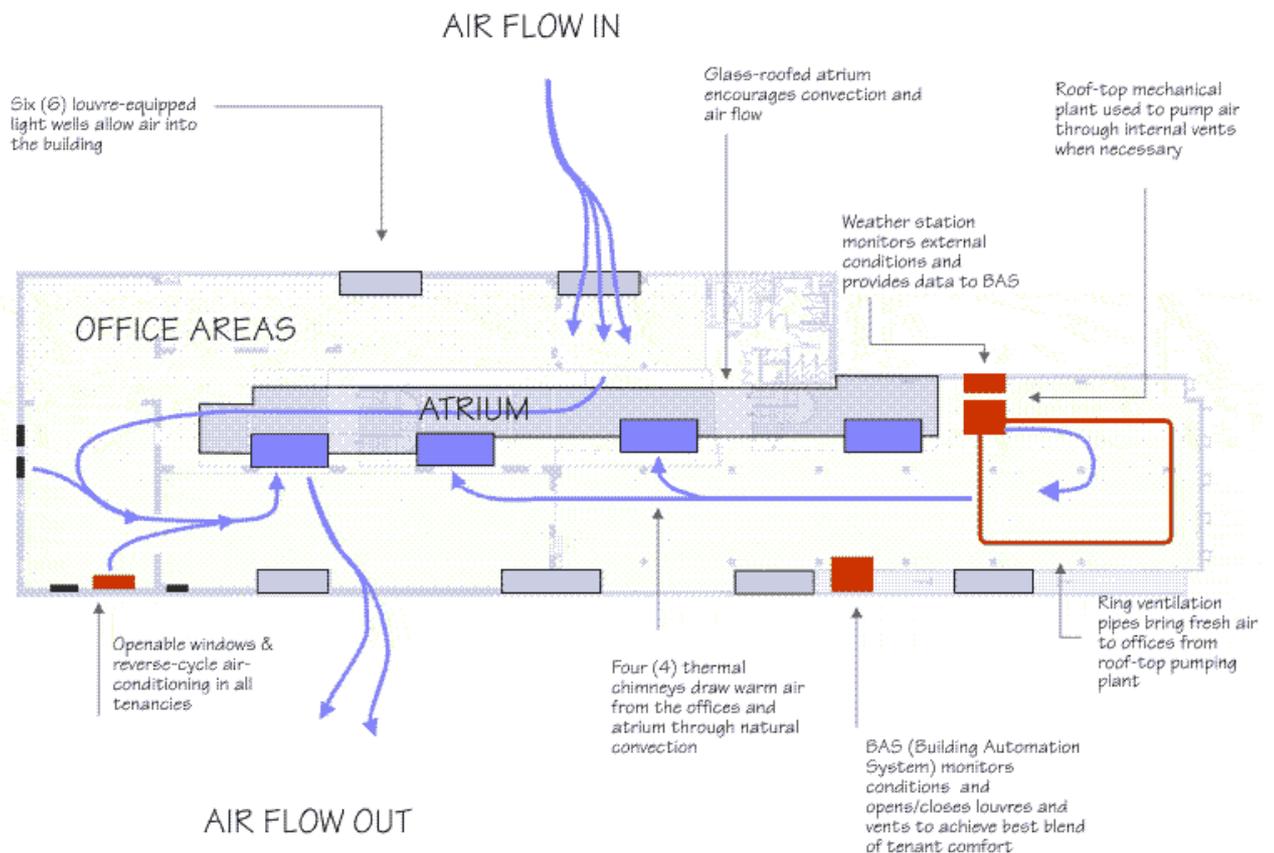
Approach

60L is designed as a holistic project. Environmental responsibility, passive design principles and low energy use have been integrated at all points in the project.

From the outset, the building has been envisaged as a circulatory system that is open to the outside world, rather than hermetically sealed.

The lightwells, louvre systems and thermal chimneys all work together through the computerised BAS to ensure effective flow of air and internal comfort.

The diagram below illustrates the flow in and out of the building:





Air flows both laterally and vertically throughout 60L. Lateral air movement, described in the schematic above can be managed by opening or closing windows and via the BAS operation of lightwell louvres.

Vertical flow is managed by the thermal chimneys, which work to heat air and expel it from the top of the building, effectively creating a convection effect which adds to air circulation.

Control needs

The building needs to operate effectively in a wide range of conditions. Melbourne has a moderate winter and an occasionally hot summer with potential for heat waves where the temperature climbs above 38 degrees celsius for several days in a row. Minimum overnight temperatures rarely drop below zero.

Within this generally moderate temperature range there are several scenarios which required special consideration. These are described below, along with typical building operating conditions which are designed to manage occupant comfort.

Scenario	Building operation
low morning temperatures in winter, especially between 7am to mid-morning	No night purging conducted the previous night so as to retain thermal mass, atrium blinds kept closed overnight and opened in the morning as outside temperature rises above inside temperature.
typical winter day, starting cold and temperature not rising above 14-16 degrees celsius all day	Even on cool days, the glass-roofed atrium will draw heat in from outside. Louvres will remain closed most of the time to reduce loss of warmth, building may be in active mode (tenant-controlled heating permitted) for part of the day.
typical summer day, starting about 12 degrees and rising to 28 by mid-afternoon	building operates in passive mode until temperature peaks - even if outside temperature is above 26 degrees, the use of lightwells and louvres can take advantage of breeze to maintain comfort. At night, heat build-up will be purged through thermal chimneys.



hot summer day with high overnight minimum starting at about 15-16 degrees and rising quickly to 35+

The building would have purged some heat build-up from the previous day. Then, as the outside temperature climbs rapidly, the louvre systems will be engaged to take advantage of wind and air temperature differentials at different points (e.g. north or south sides of the building). When internal temperature rises above 26 degrees, the building shifts to active mode and tenancy air-conditioners can be used.



BUILDING POSITION

Southern hemisphere passive solar design principles require building placement or orientation to be as close as possible to north-south alignment, with larger glass areas on the north and smaller glass areas on the south.

60L is oriented with its long sides north and south-facing. It is sandwiched between two existing buildings, so part of the design was to add a top storey so as to maximise sun and heat opportunities.

As well as providing light, the sun also provides heat, which is the power for 60L's air circulation motor. 60L works by taking advantage of differentiations in air temperature. When there is a difference between inside and out, between the top of the atrium and the bottom, between the north and south sides of the building, air will flow.



▲ 60L's open plan interior and glass-roofed atrium create a stunning work environment filled with air and light



The building's eastern facade has large windows to take advantage of morning light.

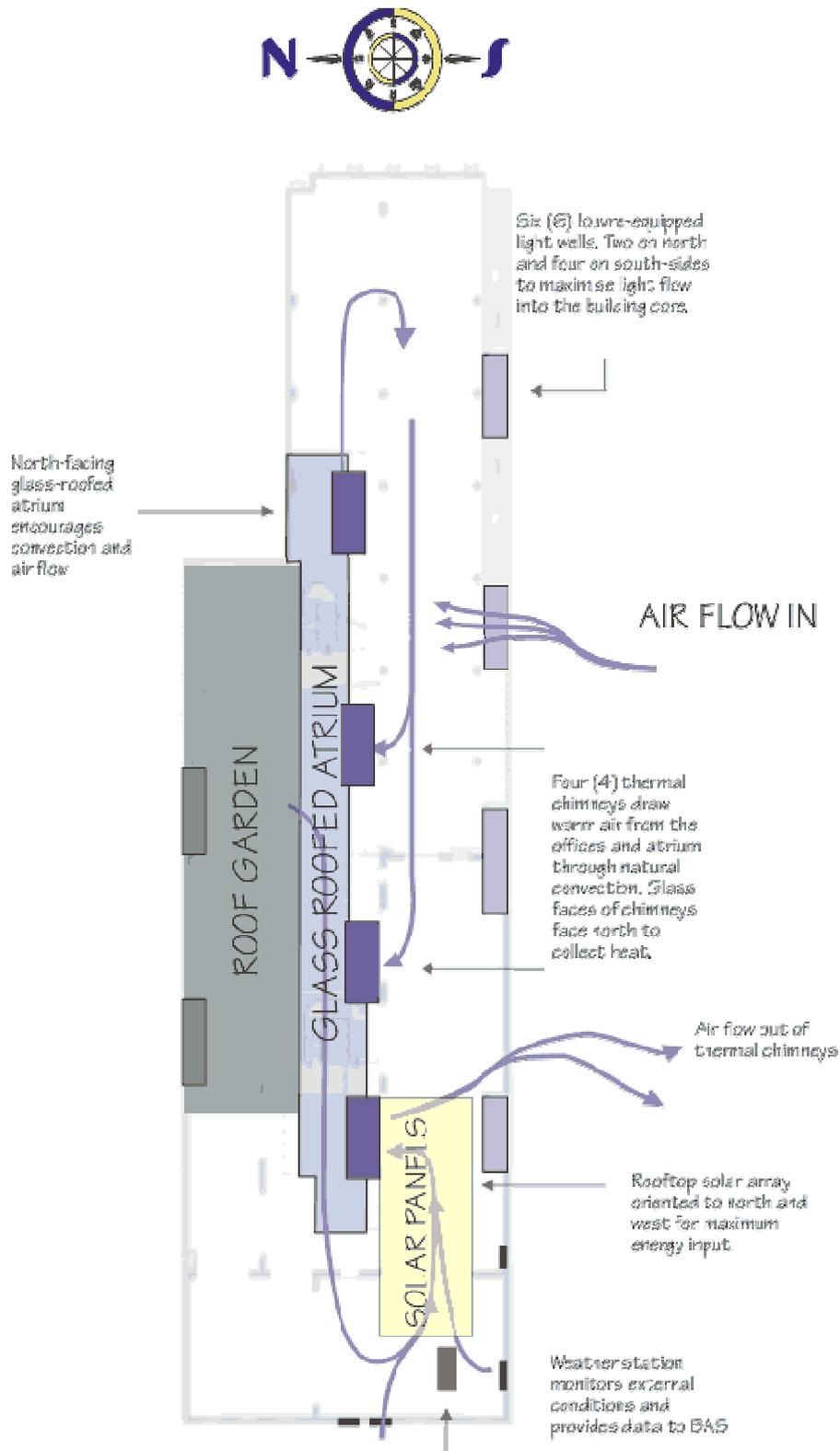


Other aspects of the building position which had an impact on design include:

- the design of the inner atrium, which runs the length of the building from east to west;
- placement of four, north-facing thermal chimneys on the rooftop, with their north-facing sides made of glass and their south-facing sides made of brick. This encourages heat to enter the chimney, creating a convection updraft to draw air out of the building and improve fresh air circulation and the disposal of heat build-up;
- the six lightwells draw air into the building from the perimeter and allow it to pass into the atrium where the glass roof heats it, which causes the air to rise and flow out through the thermal chimneys. The lightwells are situated two on the north side and four on the south side, to encourage more light and more cool air to enter from the south;
- the glass roofed atrium is north-facing to ensure maximum heat gain;
- the rooftop garden area is also designed to gain maximum winter sun, and adequate shade at the same time



60L GREEN BUILDING





VENTILATION

Natural Ventilation builds on the other design strategies that are used to manage the internal thermal load of 60L.

Exposing internal thermal mass (bricks and concrete surfaces) to the habitable space provides a thermal store and lower radiant surface temperatures. A little over 50% of the ceilings and virtually all of the perimeter walls are exposed for this purpose.



Exposed brickwork or highly effective heat sink?

60L design features are intentionally holistic in conception and simple in execution.

The use of 'night purge' when the overnight outside air temperature is below 24° to cool the building structure reduces the need for mechanical (active) cooling during the next day.

The building makes use of both the stack effect (hot air rises) in thermal chimneys, as well as wind induced ventilation.

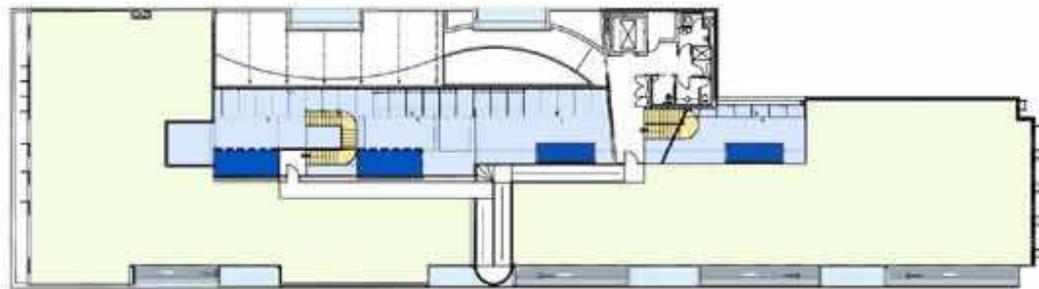
The building control system either opens the ventilation louvres when the outside air is between 19° and 26° or activates the fans depending on the outside conditions. (see section below on control strategies) This natural ventilation strategy reduces energy consumption 23% over the 'typical' commercial building base case.



Third floor

The third floor of the building is all new and is of lightweight construction. The design principles and priorities are the same for this part of the building. The end result is different on the third floor due to there being:

- more light available;
- a higher heat load because it incorporates the roof; and,
- lower thermal mass due to construction materials.



▲ 60L's third floor posed specific design problems because it is so open to sunlight. These problems were solved after extensive modelling helped the designers plan for greater air flow at this level.

Control strategies

The building automation system (BAS) controls the ventilation of 60L to maintain adequate fresh air. In between 19° and 26° the tenants can also open or close windows and ventilation louvres.

When the outside temperature is below 19° or above 26°, the BAS calls on a central ventilation plant to provide tempered ventilation make-up (replacement, fresh) air to within the defined comfort band (19°-26°).

In addition the tenants are able to control local air conditioning units in their workspace for supplementary heating or cooling as desired.

The occupants have control over some of the windows and louvres, as well as the capacity to turn the local split system reverse cycle air conditioners on or off when the outside air is not within the 19°-26° range.



Occupant/tenant behaviour

One of the factors in the design performance for the 60L Building HVAC systems is tenant behaviour. The tenants will play an active part in controlling their own thermal comfort.

As with all office space, a certain blend of negotiation, education, trial and error, and compromise will be involved in establishing and maintaining optimum comfort inside the 60L building.

Just as the 60L Building seeks to moderate ambient environmental conditions rather than isolate the occupants from the outside, so too will tenants have to consider other tenants rather than isolate their own comfort needs.

AIR QUALITY

60L's air quality meets all required standards for a commercial office building.

The absence of an airconditioning tower at 60L means nil chance of legionnaire's disease, or other respiratory problems such as flu or asthma from recirculated air.

The air circulating within 60L is at least as good as that outside. While there may be some issues about the quality of Melbourne air on particular days when a slow southerly pushes overnight smog up from the southern suburbs, the city's air quality is generally pretty high for a developed urban area.

If it is a particularly foul day outside, or for example, in the event of dust storms such as those which occurred in early 2003, the BAS can close the building louvres and pump filtered air in via the piped ceiling system (pictured at right).



60L
GREEN
BUILDING





NIGHT VENTING

60L breathes through the course of the day, allowing air to flow in and out of the building's lightwells, windows and thermal chimneys.

During the summer months, the building can be 'vented' at night: opened up so that the heat built up during the is released to the atmosphere.

This has the effect of lowering the thermal mass of the building (the amount of heat energy stored in the concrete and brick of the structure).

On a hot summer day, what happens is as follows: in the hours between, say, 6pm and 9 pm, when the summer sun is keeping the ambient temperatures high (around 30 degrees), 60L will operate in active mode, with vents and louvres closed down.

When the outside temperature drops to say, 20 degrees or lower, the BAS will open the building's vents and allow the heat build-up of the day to start dissipating.

This will continue until around 4-5am, when the outside air starts to heat up again.

As people start arriving for work, the internal temperature will be close to the overnight minimum. The atrium blinds will be closed to exclude heat, and most of the vents and louvres will be closed (except perhaps for some on the south side).

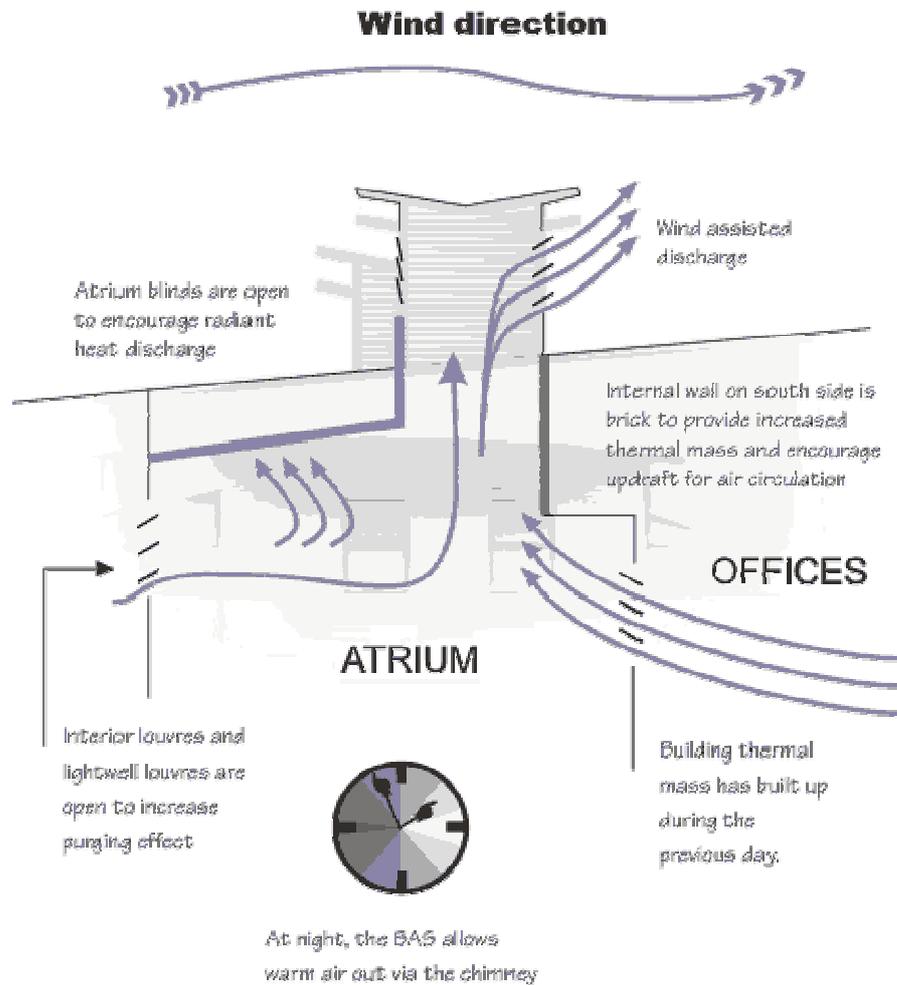
As the morning heats up, the building operates in its standard passive mode, until the temperature rises above 26 degrees, which triggers the active mode, when tenants can use air-conditioners.





Venting scenario

SCENARIO: 2am on a hot summer night. Outside temperature about 14 degrees celsius, gentle southerly breeze. Expected temp tomorrow is 42 degrees (HOT!)





3. WATER

WATER SYSTEMS – DESIGN

Water is essential to life and health.

In the case of 60L, a significant new benchmark has been set for water consumption in commercial buildings.

60L's approach to water conservation can be summarised through the following:

- minimise the demand for water by providing water efficient fixtures & fittings, including water-less urinals and low flush volume toilet pans;
- use collected rainwater to replace 100% of normal mains water consumption whenever possible;
- 100% on-site treatment and reuse of grey-water (basins and sinks) & black-water (sewage) streams to produce reclaimed water for flushing toilet pans and irrigating the roof garden and landscape features;
- use of reclaimed water for flushing toilet pans and irrigating the rooftop gardens.

In an average rainfall year, only water required for testing the fire sprinkler system will require the use of mains water. 60L will use 90% less mains water when compared to a traditional commercial building of similar size and function.



60L GREEN BUILDING

The building relies principally on rainwater. This is collected from the roof, stored in two 10,000 litre tanks on the ground floor, filtered and then sterilised prior to use by tenants in taps and showers. More than 500 kilolitres of rainwater will be collected in an average rainfall year.

Water efficient fixtures & fittings have been used throughout.



Two 10,000 litre tanks collect and store rainwater

Waste water generated within the 60L building will be processed in a biological treatment plant as part of the commitment to the principle of dealing with the waste one produces rather than passing it on for someone else to deal with. Recycled water from the waste water treatment plant will be used for flushing toilet pans and irrigating the roof garden and landscape features.



Rainfall from the roof is harvested, then transferred into the holding tanks via a 'Syfonic' system, which uses gravity to create a syphon effect, which means water transfer is faster and pipe diameter can be greatly reduced.

There are three basic sub-systems which go to make up the 60L water system:

- *Potable water system*: harvesting, collection transfer and sterilisation of water for use by tenants and building systems (view/download simplified pdf schematic of [potable water system](#));
- *Sewage treatment system*: biofiltration and clarification of waste water for use within the building and transport of treated waste to city system (view/download simplified pdf schematic of [sewage treatment system](#));
- *Reclamation system* : reclaimed water, treated to appropriate standards, will be used on 60L's roof garden, in toilets and in the final part of the system, a reed-bed water feature in the atrium which filters water before it returns to the city system (view/download simplified pdf schematic of [reclamation system](#)).



WATER SYSTEMS – TECHNOLOGY

DEMAND MANAGEMENT

The most important people in terms of determining how much water will be used are, of course, the building occupants.

In an average commercial building, individual occupants have little idea about the amount of water being used by the occupants as a whole.

The 60L Building has feedback mechanisms that encourage tenants to adopt best water conservation practice.

EFFICIENT FIXTURES AND FITTINGS

The combination of demand management and water efficient fixtures and fittings, such as low-flow shower heads and waterless urinals, can reduce overall water usage by about two-thirds.

Efficient shower heads that discharge 5 litres of water per minute, compared with conventional 11 litre per minute shower heads, can save more than 40 litres in a standard seven-minute shower.

Six, 3-litre dual flush toilets have been selected on the basis of their high efficiency, and suitability for flushing with recycled water from the building's effluent treatment plant.

WATERLESS URINALS

Few of the 60L building's fixtures raise as much interest as the waterless urinals.

Though relatively new to Australia, this eminently sensible product has been used for some time in Europe and the USA.

The need to use precious water for flushing is eliminated. Urine passes through a special trap cartridge in the bottom of the urinal which contains an oil seal, preventing undesirable odours from escaping. The cartridges are usually replaced after about 8,500 uses, and cost about \$40 a year for each urinal.



RAINWATER COLLECTION

With the 60L Building located in Melbourne, a city where rainfall is notoriously difficult to predict, it was important to determine whether a water collection facility would be capable of gathering sufficient water to meet the demands of the building and its occupants.

Analysis of data was also required to determine the optimum size of such a system. Two tanks, each of 10,000 litres capacity, have been installed on the ground floor of the building. In an average rainfall year, it is expected that about 500 kilolitres of rainwater will be collected for use by shower and taps.

The building should be self-sufficient in an average rainfall year, except for the need to test the fire sprinkler system on mains water.

DRINKING WATER TREATMENT PLANT

The collected rainwater must be filtered and treated to guarantee that it is 'potable' or safe for human consumption.

When there is a demand for water (from a tenancy), the rainwater is pumped through a three-stage filtration and UV sterilisation system, which removes water impurities.

This process is managed by a central water and wastewater system controller.

This treatment plant has automatic monitoring for conductivity and is subjected to routine monitoring and testing for microbial activity.

UV STERILISATION: HOW IT WORKS

UV Sterilisation makes it possible to kill potentially hazardous organisms and bacteria without the need for chemicals such as chlorine. Ultra Violet light destroys the cell structure of pathogens thereby making it impossible for them to reproduce and pose a risk to water users.

UV systems have become widely accepted for drinking water sterilisation.



SEWAGE TREATMENT PLANT

All the wastewater from basins, sinks and showers in 60L together with all the sewage from the toilets is collected in an underground tank. This combined effluent is then treated to make it suitable for reuse within the building.

The Sewage Treatment Plant, located on the ground floor at 60L, is a biological treatment system, free of chemicals, that allows natural organic processes to convert the organic material in the effluent. The plant has a series of compartments in which the effluent is successively treated by sedimentation and digestion, bio-filtration, and then clarification before being discharged into a water storage tank which forms part of the Reclaimed Water Treatment Plant.

RECLAIMED WATER TREATMENT PLANT

Reclaimed Water from the Sewage Treatment Plant is pumped through a separate two-stage filtration and UV sterilisation system to make it suitable for flushing all toilet pans, and for use in sub-surface irrigation of the roof garden and other landscape features. This treatment plant also has automatic monitoring for conductivity and is subjected to routine monitoring and testing for microbial activity.

Surplus reclaimed water will be discharged via a water feature in the building atrium, with a succession of cascading tanks containing aquatic plants and organisms to provide a third stage of purification.

WATER SYSTEMS – MATERIALS

- tanks;
- pipes;
- syfonic system;
- transparent pipes.
- pumps (location and size/rating);
- sewage plant;
- filtration plant.



WATER – CONSTRUCTION

Water is such an important issue in Australia that we decided to place it on show for tenants and visitors to 60L. Thus the 2 x 10,000 litre storage tanks and ancillary pumping, filtration and water sterilisation equipment are clearly visible on the ground floor.

Throughout the construction process, wherever possible, it was decided to make water use a prominent aspect of the built environment. Pipes that collect and transport water are clearly marked. Some collection pipes have transparent panels that enable tenants to see the flow of water into the rain tanks when it rains.

The Syfonic rain water collection system is a high efficiency way of moving water into the storage tanks via gravity and syphoning; it minimises downpipe sizing and saves on materials usage.

The rooftop garden is designed to be watered with reclaimed water from the on-site wastewater & sewage treatment plant.

From a construction viewpoint, it was important to have a completely integrated design from the outset, so that synergies in saving - both during construction and afterwards - could be realised.

This is basic sustainability theory - plan, design, specify and build with the avowed intent of using less resources at all stages. For example, the water treatment plants use



only half the number of pumps and motors that would otherwise be the case due to careful attention to design and the involvement of the manufacturer and sub-contractors early on in the process.

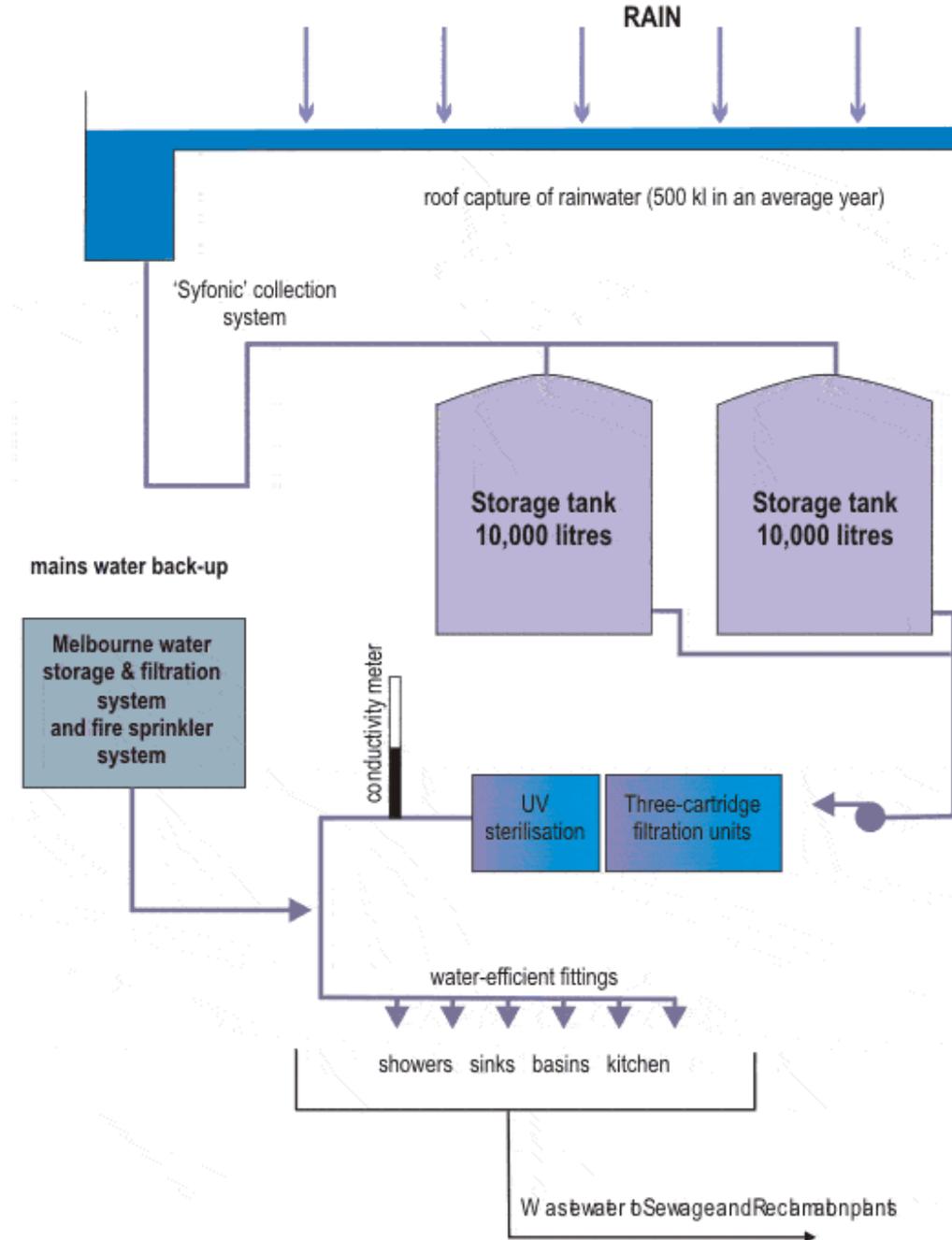
WATER TREATMENT AND RECYCLING

There are three separate, but inter-linked systems for dealing with water at 60L:

1. the collection and purification of rainwater for use in the building for all the normal purposes, including drinking, taps & showers, and washing;
2. the treatment of wastewater & sewage generated in the building to provide reclaimed water for flushing toilet pans and irrigating landscape features;
3. the use of reclaimed water for flushing toilet pans and irrigating landscape features.

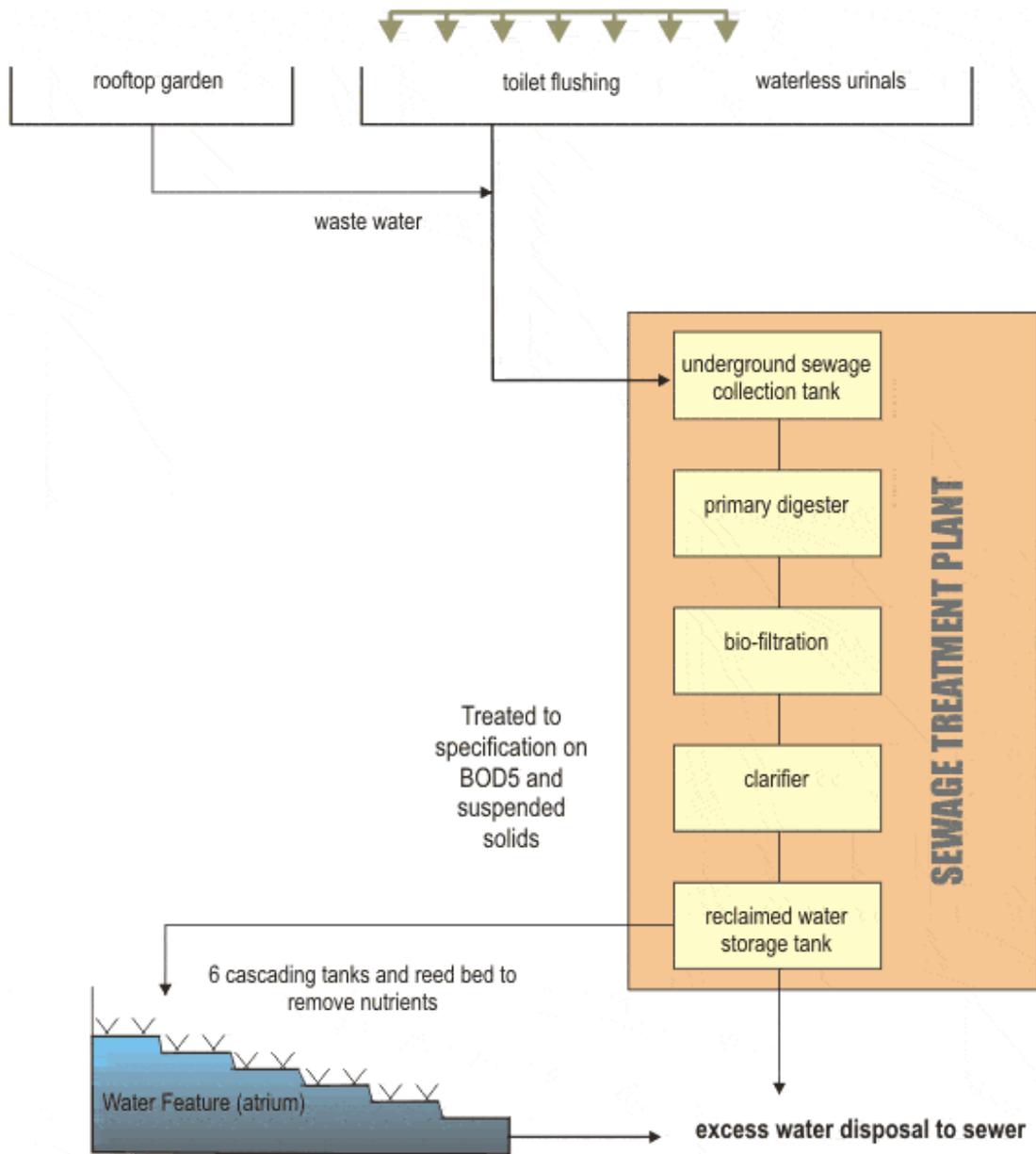


Collection system



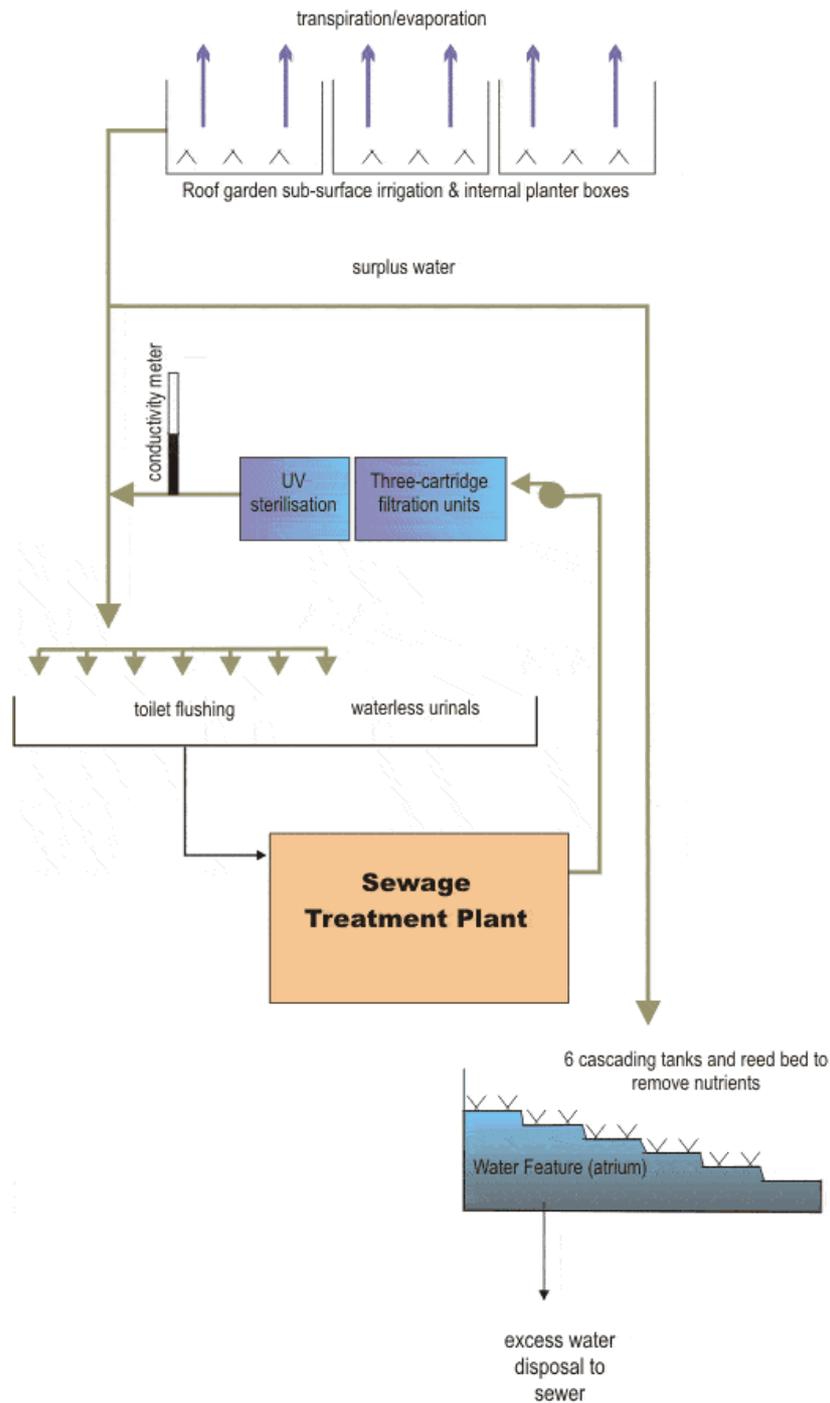


Sewage treatment system





Water reclamation process





WASTE WATER

60L is designed to have as close to zero greenhouse gas emissions as possible.

Accordingly, the water system is designed to return water to the environment in the same condition - or even better - than when it was collected from the roof.

Potable water - that is, water which is used for drinking and washing, or in sinks and appliances such as dishwashers - is produced by sterilising and filtering rainwater collected from 60L's roof. Potable water is used once, and then transferred to the building's sewage and water reclamation systems.

In the sewage plant, waste water ('grey water' from sinks, showers and appliances) together with human waste ('black water' from toilets) and any overflow that is diverted if, for example, the water tanks are full, goes into an underground sewage tank where it undergoes bacterial digestion, bio-filtration and clarification, before being pumped into a reclaimed water holding tank.

The resulting reclaimed water is then used on 60L's rooftop garden and in toilets and the atrium water feature.

Water from the garden and toilets returns to the sewage plant after being used, where it is again treated and may be used again and again.

60L's centrepiece water feature - a six-tiered reed bed planted with native species - performs both a symbolic and practical function. The water that flows through the water feature comes from the reclaimed water holding tank. By passing through the reed bed, which mimics a wetland micro-ecology, waste water undergoes a final filtration process before being returned to the sewer.

RAINWATER

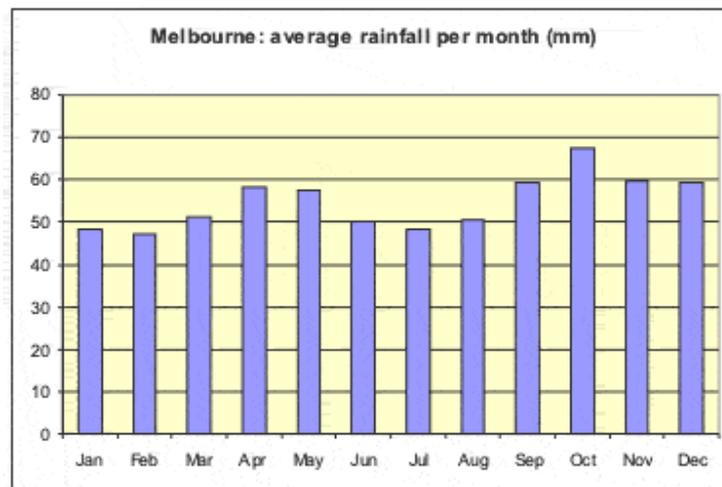
Rainwater harvesting

60L collects all its necessary water from an extensive rooftop collection system. The water is channeled to two 10,000 litres storage tanks placed in the main atrium.

In an average rainfall year, 60L will be able to provide all the water needed by tenants.



Melbourne has a reasonably good rainfall distribution. While there are clearly differences in the seasons, there are no seasonal extremes of wet and dry. February is the driest month, with an average of about 47 mm, while October is the wettest with 68mm. The chart below shows the average monthly rainfall for Melbourne (source: Bureau of Meteorology).

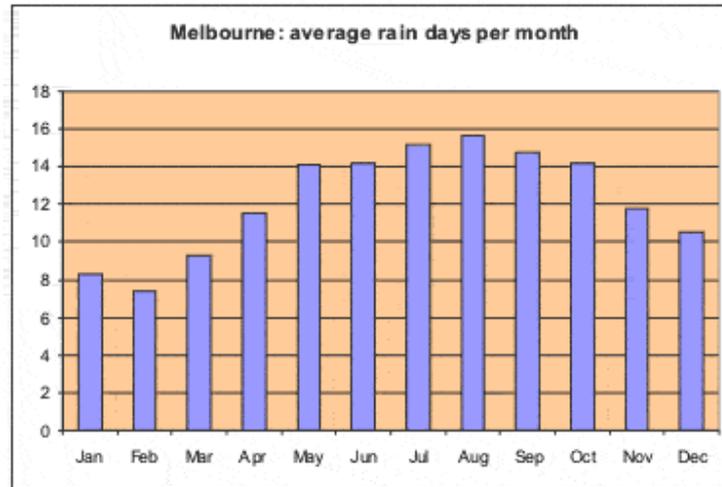


Another issue for the designers was not just the amount of rain, but when it fell. Again, we are fairly lucky in that Melbourne has an even rainfall pattern when it comes to the number of days each month which might produce rain.

The chart below shows the average number of rainy days per month for Melbourne (source: Bureau of Meteorology). With the exception of January to March, we can usually expect rain at least ten days out of every 30.



60L
GREEN
BUILDING



APPLIANCES

Ride a bike? Well, yeah, I would if they had decent showers at work.

As well as the water-saving toilet cisterns and waterless urinals, 60L has showers on each floor which are intended for use by tenants. Like the toilet area, these are fitted with stainless steel fittings, some of which, such as in-floor drain covers were specially sourced or made when no suitable fittings existed on the market.

As with all aspects of 60L's design and construction, low energy options were chosen wherever possible. Thus, chrome was avoided throughout bathroom and toilet areas.

Within kitchen areas, chrome is again avoided.

High energy rating appliances are used throughout.



WATER CONSUMPTION

The people most central to determining how much water will be used are, of course, the building occupants.

In an average commercial building, individual occupants have little idea about the amount of water being used by the occupants as a whole. The 60L Building on the other hand, with its emphasis on water conservation, will provide feedback to tenants on the amount of water being used and the amount of rainwater available.

As generalised data comes on line, we will be posting it here.





4. ENERGY

HEAT LIGHT AND ENERGY USE IN 60L

When we talk about 'fire', we mean those aspects of the building which supply or deal with heat and light.

60L achieves better commercial performance by maximising daylight throughout the building, which, in turn, reduces the capital cost of artificial lighting and the ongoing operating cost of power for the lights and for removing the heat produced by the lights.

Energy Design Principles

Design principles underpinning 60L's electrical energy use are based on the idea that the building should, to the greatest extent possible, generate zero greenhouse gas emissions.

In real terms, what we have achieved is a building which will use only about one-third as much energy as a traditional commercial development of the same size. Further, 60L uses only green power, so the actual greenhouse gas emissions produced by the building energy systems are very close to zero.

The following strategies were included in the design:

- minimise the demand for energy through equipment design, technology selection, taking advantage of passive design strategies and an expectation of responsible environmental behaviour by the building occupants;
- purchasing 100% Green Power from the electricity retailer to provide zero greenhouse gas emissions;
- generate power through a rooftop solar array.

Building orientation

North and west facing facades include large glass areas that take advantage of winter sun. A large inner atrium with light shelves also brings sunlight into the core of the building.

Six light wells in the building perimeter also bring light into the inner areas of the tenancies. 60L uses 100% green power - electricity bought from a provider who commits to source the same amount of power from a renewable source.



A rooftop solar array generates power for use in the building. In times of low demand, the solar array supplies energy back into the electricity grid. The fit-out specifications require tenants to use energy efficient appliances wherever possible throughout in the building fit-out.



◀ A rooftop solar array contributes green power to 60L

Individual tenancies control comfort via split-system reverse-cycle air conditioners. ▶



The building heating system is designed to make the best of passive design principles. Heat that has been absorbed during the day into the brick and concrete structure can be eliminated at night by using the computer-controlled louvre venting system.

60L's energy systems are a good example of the environmental and cost benefits that can accrue through a [hierarchical approach to design](#).

ENERGY – TECHNOLOGY

60L is designed to maximise the use of daylight. The building design, with its central atrium and light wells, will enable 60L to use about 80% less energy for lighting when compared to a typical commercial building design of the same size. The ideas used at 60L offer simple alternatives by creating comfortably lit environments that amount to big savings in lighting costs and improved overall productivity.

Energy - in the form of light, heat and electricity - is one of the areas where it is possible to see the impact of blending passive and active design features. The technology is sophisticated where necessary, but does not overpower the aesthetic simplicity of the building.



Systems such as the hi-tech computerised automation system blend well with the low-tech solution of deep light wells and static light shelves. Features include:

- Passive features - natural lighting, 50% open (non-tiled) ceiling areas, light shelves and reflecting surfaces draw light into the building core;
- Roof Insulation (R-rating 3.5), with insert strips to minimise heat leakage, astro-foil, insulated gutters, double-glazed and laminated low-E design windows and window tinting;
- Heating - managed through light well and venting system, plus energy efficient, zoned, reverse-cycle air-conditioning units in individual tenancies;
- Lighting - energy-efficient lamps, fluorescents and ballasts;
- Power - 100% green power is purchased from Origin Energy. Rooftop photo-voltaic arrays collect solar energy that will provide about 10% of the 60L power needs, and feeds surplus power into city grid when building operations are minimal i.e. over the weekend and at holiday times;
- BAS - Building Automation System provides the building manager with real-time data on environmental performance.



ENERGY – CONSTRUCTION ISSUES

60L has a complex integrated energy supply system that works at many levels: from the passive, low-tech lightwells constructed from glass, recycled bricks and timber through to the computerised sensors which gather data for the building automation system, and the small electric motors which operate 60L's louvre system.

For the designers of 60L it was important to develop ways of achieving this integrated result, yet no such product existed in an off-the-shelf condition. It was necessary to source various sub-systems and work with suppliers of different elements to ensure the whole lot worked together to achieve the synergistic results required.

As a result, 60L uses less than 35% of the electricity of a typical building of the same size and function.

It has achieved an 80% reduction in the energy used on fluorescent lighting by using single-tube, high efficiency units and a lighting plan that makes best use of the open areas of the building.

60L saves 60% of the energy that would be expected to be used to supply heating and cooling to a typical building of this size and purpose.

People and appliances

Commercial office buildings are places where people use office equipment - lots of it. Computers, printers, photocopiers, faxes, scanners, dishwashers, water heaters - you will find dozens of machines on the floor of any contemporary commercial building.

These machines both consume electrical energy (for which tenant pays) and produce waste energy in the form of heat (which the tenant then has to pay for to remove from the building).

For example, an average PC with screen will produce approximately the same amount of waste heat as a human being. In other words, if there are a hundred computers in your office, it's like having a hundred people extra standing around.

In the public and semi-public areas of 60L (such as kitchens) 5-star energy efficient appliances are standard.



Tenants are encouraged to fit out their offices with energy efficient appliances through a range of support processes which include detailed fit-out guidelines, an orientation guide describing the philosophy and approach of the building designers, and a 'green' lease.

ENERGY EFFICIENCY

In most cases, the greatest environmental impact of a building results not from the process of construction but from ongoing need for energy to keep the building functioning.

This makes thermal energy efficiency the crucial starting point for designing a green building. Thermal energy efficiency is influenced by factors across a range of disciplines. This makes it necessary to address these factors in a way that transcends the traditional linear model of building design.

Over the last ten years, a new field of engineering, climate engineering, has arisen to meet this need. Climate engineers work with architects to create integrated, balanced energy concepts that optimise thermal and visual comfort and minimise energy and equipment costs. In the case of 60L, this role was performed by Advanced Environmental Concepts.

Energy efficiency can be dramatically improved by:

- maximising the amount of insulation and minimising the number of air leaks and drafts in a building;
- designing to limit cooling loads cutting the need for air conditioning;
- making use of renewable energy sources like solar energy;
- selecting energy and water efficient appliances, fittings and equipment.



Starting from the building envelop and working through a hierarchy of elements, 60L's design team produced a building that uses only one-third of the electrical energy of a typical building of the same size and purpose.

In net terms, 60L produces zero greenhouse gas emissions. This is achieved through attention to the design process, use of offset tree-planting and purchase of Green Power augmented by the rooftop solar array.

All appliances used in the public areas of the building are high efficiency appliances. As part of the fitout and leasing process, tenants are encouraged and supported to fit energy efficient appliances in their offices.

NATURAL LIGHT

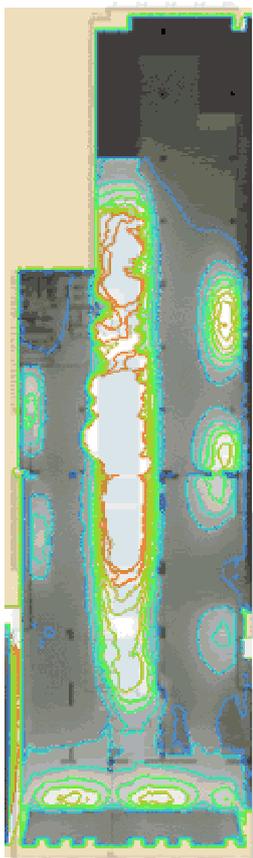
60L is designed to maximise the use of daylight. The building design, with its central atrium and light wells, will enable 60L to use about 80% less energy for lighting when compared to a typical commercial building design of the same size.

The ideas used at 60L offer simple alternatives by creating comfortably lit environments that amount to big savings in lighting costs and improved overall productivity.

The charts below show computer modelling of the penetration of natural light via the building's main atrium and five lightwells. The higher the Daylight Factor (DF) the more light.



60L GREEN BUILDING



Computer modelling shows how light penetrates via the atrium roof and lightwells.

Legend below shows amount of light penetration.

Daylight factor



Ground Floor



Computer modelling shows how light penetrates via the atrium roof and lightwells.

Legend below shows amount of light penetration.

Daylight factor



Second Floor

Measures to diffuse light and cut glare mean that the light provided is of a qualitatively higher standard than light in everyday office environments.

Some of the key measures at 60L include:

- The new building form has been largely guided by the integration of natural ventilation and lighting strategies. Most notably this can be seen in the installation of a large central atrium and five light wells. The careful placement of these features allows them to perform dual lighting and ventilation roles.
- Austint Green glass was chosen as giving the best balance of reduced solar heat load - 51% reduction - while retaining 78% visible light transmission.



- Cloth shading devices and light shelves have been added inside the building atrium and light wells to throw light inwards while reducing required area (and therefore thermal gain/loss) of light wells.

The designers also made distinctions between the various functions of parts of the building. For example, Australian Standards dictate a minimum of 160 lux for background or general purpose lighting levels, and 320 lux for reading, writing and typing.

Yet, many commercial buildings are lit to a 320 lux level throughout. At 60L, general purpose areas, hallways and public areas have been designed with this lower requirement in mind.



Third floor

The third floor of the building is all new and is of lightweight construction and has considerably higher availability of natural light.

The design principles and priorities are the same for this part of the building. The end result is different on the third floor due to there being more light available, a higher heat load because it incorporates the roof, and lower thermal mass due to construction materials.



Use of daylighting on the third floor has led to lighting energy consumption being about a quarter of that expected for a typical office building.

GREEN POWER

Green Power is electricity generated from clean, renewable energy sources, such as solar, wind, biomass and hydro power.

Australia's per capita emissions of greenhouse gases are amongst the highest in the world. Over 90% of electricity generated in Victoria is generated from coal-fired power. This form of electricity generation accounts for over 50% of the State's greenhouse gas emissions.

60L's power is purchased from Origin Energy.



A National Accreditation Program has been developed to ensure that Green Power offered by electricity suppliers is generated from approved renewable energy sources.

Green Power is a product where the generation source:

- results in greenhouse gas emission reductions;
- has nett environmental benefits;
- is based primarily on a renewable energy source.



A generation source that could cause significant environmental or cultural damage, even if considered renewable, will not be approved. For instance, major flooding hydro projects would not be approved.

Accredited Green Power retailers must submit regular reports to ensure that sufficient approved renewable energy is purchased to meet customer needs. Revenue from the schemes must be independently auditable and retailers themselves must purchase Green Power for their own purposes.

Retailers must commit to the development of new renewable generation. Retailers must source a minimum of 80% of their Green Power from 'new' renewable sources developed since 1997. This acts as an incentive for a viable renewable energy industry in Australia.

PASSIVE ENERGY FEATURES

The main passive feature of 60L's energy efficiency strategy is simple: use daylighting wherever possible to minimise the need for artificial lighting. This is achieved through significant glass areas, including the atrium roof and five lightwells on the north and south perimeters.

Other passive features include:

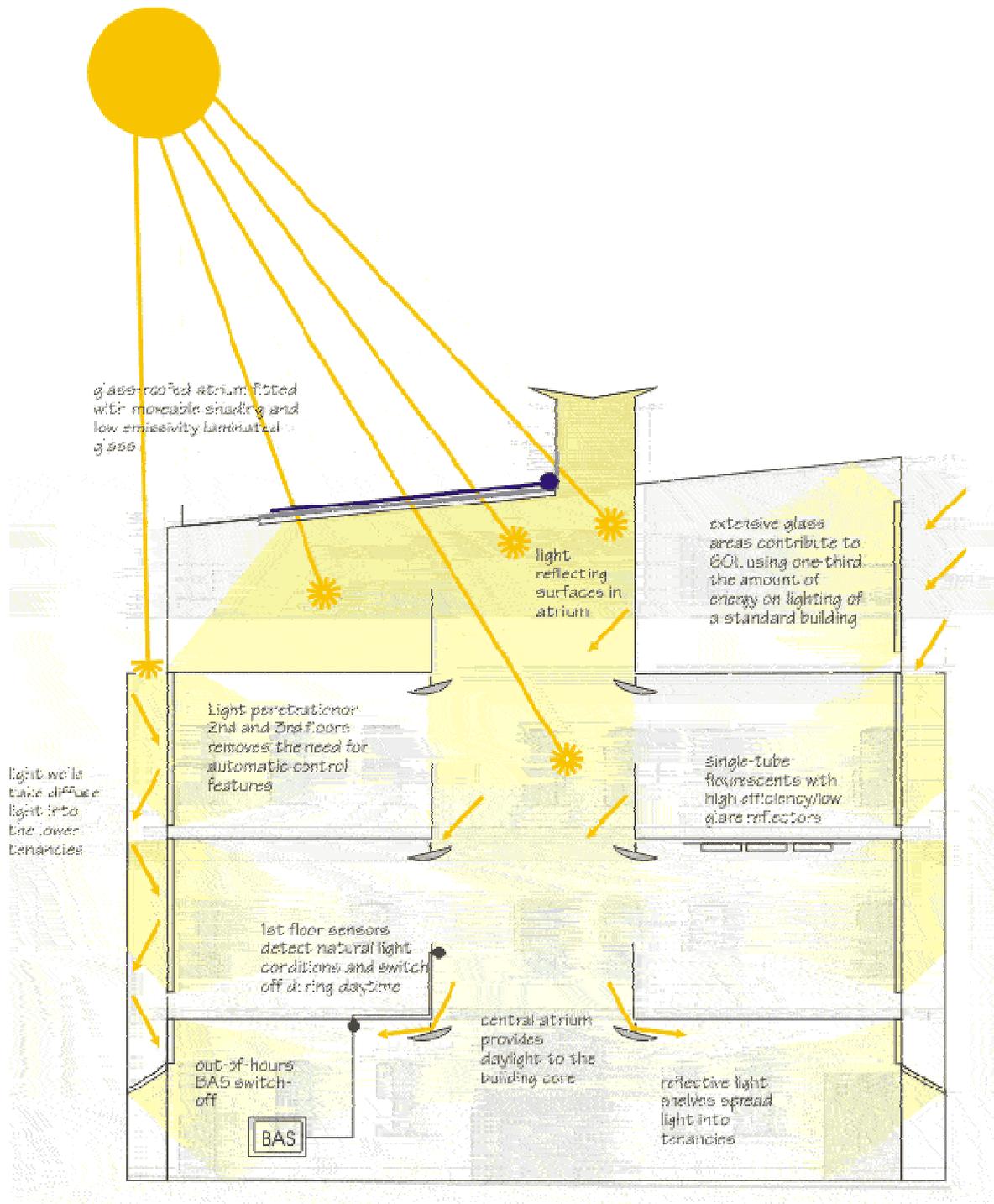
- light-reflecting surfaces in the atrium and open plan design bring light into the building core;
- reflective light shelves angle light into tenancies;
- retractable shading on the atrium roof manages heat and light glare on bright summer days.
-



The diagram below shows how light enters the internal part of the building.



60L GREEN BUILDING





ENERGY CONSUMPTION

60L uses about one-third of the electricity of a typical building of the same size and function.

In an average year, this is expected to be 250mWh. As described elsewhere, 60L uses Green Power - energy purchased from a retailer (in our case, Origin Energy) at a premium. In return for which, the retailer agrees to source the same amount of power from sustainable energy sources such as wind, solar, biomass and some hydro.

60L's demand for grid energy is offset by the solar array installed on the roof. It is a relatively small array, and in no way is it intended to provide for the building's full power needs. The truth is that solar panels are not yet technologically advanced-enough to provide fully for the demands of a commercial building.

However, with every design generation, performance is improving and several promising developments will come on-line in the next decade. We believe, therefore, that it is important to commit to utilising the technology even though it is not perfect. It will never achieve adequate economies of scale and market penetration if we all wait for the gold-plated, failsafe, 100% performance model.

In the 60L atrium, outside the Building Environmental Manager's office, there is a live-time display showing how much solar energy is being generated by the rooftop array, and consequently, how many tonnes of greenhouse gas emissions have been saved.



Another aspect of the overall energy efficiency of 60L is the offset tree-planting program.

As a recognition that the building still has an environmental footprint, despite being current best-practice, many hectares of native trees have been planted in western Victoria, near Hamilton.



ARTIFICIAL LIGHTING

60L achieves significant savings when it comes to artificial lighting.

Initially, the passive design features of the building mean less need for installed lighting.

Secondly, the type of lighting units chosen were high-efficiency, single-tube units.

Thirdly, the designers also made distinctions between the various functions of parts of the building. For example, Australian Standards dictate a minimum of 160 lux for background or general purpose lighting levels, and 320 lux for reading, writing and typing. Yet, many commercial buildings are lit to a 320 lux level throughout. At 60L, general purpose areas, hallways and public areas have been designed with this lower requirement in mind.

Together, these initiatives mean that 60L has achieved an 80% reduction in the amount of energy used for lighting, when compared to a typical building of this size and function.

Light fittings

Use of high efficiency light fixtures reduced the installed lighting load to 7W/m² compared to a more typical 20W/m² for office buildings.

The light fittings used are 36W single tube with non-dimmable electronic ballast on a nominal 2.4m spacing.

The tubes are triphosphor, low mercury type in fixtures with semi-specular reflectors and 10 cell low glare, louvres.



In addition to efficient fittings, efforts have been made to keep the undersides of ceilings as light coloured as possible, and fittings have been arranged over work stations to ensure light is where it is most required. Careful placement has enabled about a 15% reduction in the number of fittings compared with a regular grid.

Lighting controls

The lighting control system does not under any circumstances, switch lighting ON. The system is an 'auto OFF - manual ON' operation.

The lighting is connected into circuits that reflect local area lighting needs. About every eighth tube is connected to a 'security' circuit enabling safe passage about the building out of hours. The rest of the lights are able to be locally switched on by the occupants.

There are photocell sensors on local circuits to switch off lighting when levels reach 320 lux at work surfaces. When daylight levels taper off manual intervention will be required to re-instate artificial lighting.

The whole building's lighting is connected to a time clock and is switched off out of office hours. Occupants are able to switch lighting back on.

This is a consistent theme: occupants have control to switch lighting on at all times, but the building defaults to switching lighting off whenever an available opportunity arises.



5. PEOPLE

HEALTH AND ACCESS

Ultimately, buildings are about people, not technology. They exist to provide clean, safe and healthy environments in which we can live, work and enjoy ourselves.

60L involves and empowers its tenants. The people who work in 60L are encouraged to make choices that can further reduce the environmental impact of the building.

This occurs through:

- 'green' leases - which include agreed and legally enforceable processes for ensuring that the ongoing environmental management and operation of the building by tenants is based on the principles of shared responsibility, sustainability and waste reduction;
- environmental information system - a computer-based Building Automation System that manages and provides real-time data on the performance of the building's energy, water and waste systems;
- involvement of the community of tenants in building management and decisions.



Other specific aspects of design and construction that contribute to the health of tenants include:

- large bikerack and showers to encourage people to bike it;
- no on-site car parking - a deliberate decision to encourage people to walk, ride or use public transport;
- elimination, wherever possible, of glues, sealants and paints using volatile chemicals the 'outgas';
- restrictions on the use of plywood and chipboard wood products, which contain harmful glues and preservatives that outgas;
- reduction of synthetics wherever possible in furniture and floor coverings;
- 60L is a no-smoking building in all areas, including tenancies, common areas and the roof garden.

Disability access

60L has two prominently-placed staircases which are unashamedly 'front-and-centre' for tenants and visitors. We very much want to encourage people to use the stairs rather than the lift, which is placed more towards the back of the atrium.

However, for those who do not use stairs, there was a conscious decision to integrate disability features into the design from the beginning. In this way such features appear to as a standard aspect of the building design, rather than an after-thought to comply with local by-laws.

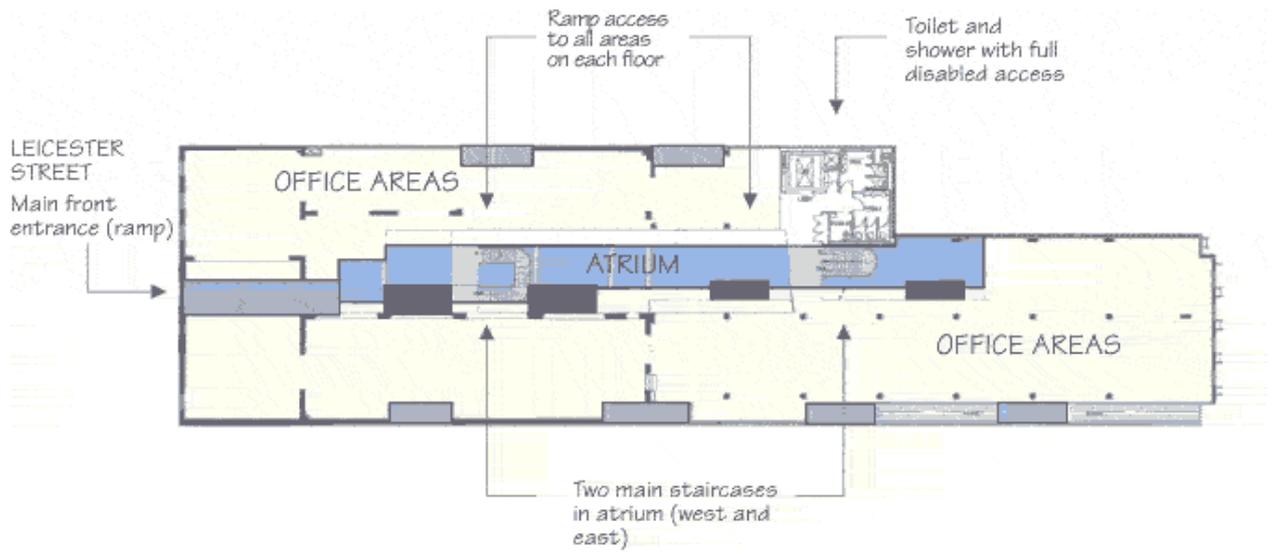
Specific features include:

- ramp access to all parts of the building - once you enter 60L it is possible to go anywhere without using stairs or steps;
- dual audio and visual emergency alarm system to provide better security for people with a hearing or sight disability;



60L GREEN BUILDING

- o braille buttons in the lift;
- o disability-sensitive fittings in handbasins and showers.





COMMUNITY

While 60L is first and foremost a commercial building venture, it is also an 'intentional community' - a place where people who are interested in reducing global and local environmental problems can undertake work in the knowledge that the building itself will contribute to their health and productivity.

60L achieves its environmental success by blending technology and people.

It is important to us that the building community is empowered and participative - that 60L is a place where people agree that environmental action involves taking individual responsibility.

This is achieved through:

- a manual for tenants on the building's many environmental and energy features;
- an orientation kit provided for tenants and their employees;
- tenant briefings on various aspects of the building; w tenant access to information from the Building Automation System, so that they can monitor their own use of energy and the building's water consumption;
- integrated management procedures for handling residual materials and solid waste that make it easy for tenants to reduce, reuse and recycle.

Comfort and control

60L gives people working in its offices greater control over their personal comfort and local environment.

A typical block commercial building, even if it has zoned air-conditioning, does not allow for much in the way of localised control of air and temperature, especially once the first partitions are moved and the air-conditioning system performance starts to go haywire.

In offices (as opposed to public areas) 60L has a combination of adjustable components which provide comfort control :

- individual domestic-type reverse-cycle air-conditioners for heating & cooling;



- openable windows and louvres.
- minimal use of plastics, adhesives & sealants which emit volatile organic compounds (VOCs), means healthier air inside the building;
- higher than normal use of daylighting also helps people feel more comfortable throughout the building.

60L is a no-smoking building in all areas, including tenancies, common areas and the roof garden.

Features for tenants and visitors with a disability

60L's designers took seriously the provisions of the Disability Discrimination Act, which ensures that people, no matter what their situation, should be able to come and go, and use commercial facilities as equal members of the community.

Some of the features which have been designed into the building include:

- wheelchair access to all tenancies;
- audio and visual emergency warning system;
- tactile tiles at level changes;
- disabled toilets on each floor;
- disabled shower;
- braille signage in lift.

60L'S GREEN LEASE

The 60L Green Lease is based on the premise that the performance of the building is critically dependent on the co-operation and behaviour of the tenants.

There is little point in having the world's most efficient technology unless that technology is going to be used in an efficient manner.

To this end, the lease includes clauses in plain English to preserve and ensure the continued environmental performance of the building.

Components of the lease documents include:

1. The Agreement for Lease and The Lease



2. The Green Building Principles and The Green Building Rules

3. The Environmental Management Plan (EMP)

4. Tenancy Fit-out Manual and Fit-out Schedule.

Options

In order to make a building as environmentally sustainable as possible, some form of regulation and monitoring of tenant behavior is required.

While other companies have implemented EMPs, the approach taken for the 60L building is unique as it incorporates compliance with the EMP as part of the legally binding lease agreement.

This is intended to firmly place environmental management in the framework of standard commercial leasing arrangements in an effort to increase awareness of the role individual action takes in achieving good environmental outcomes.

The lease documents also recognises the obligation, on the part of the building owner, to make information and advice as easily accessible as possible.

Energy Management Plan (EMP)

The EMP provides tenants with information on installation, sourcing and workplace practices to cover every facet of the green tenancy. For example, the EMP points out, "Unattended computers with complex screensavers generating 20-100+ times as much waste heat as necessary are unfortunately commonplace".

The EMP has been prepared by Sustainable Solutions Pty Ltd in conjunction with the Australian Conservation Foundation and the Green Building Partnership, with assistance from the City of Melbourne.

It provides advice in sourcing office equipment and materials for fit out; practices for tenancy operation, tenancy fit out and the relocation of the tenancy.

There is also a fit out manual and fit out specifications in the lease.

The building managers provide additional information and advice to tenants on sourcing the most environmentally appropriate materials.



Office waste

The lease agreement incorporates clauses with regard to tenant and landlord responsibilities for ensuring a high level of environmentally sustainable outcomes.

Individual bins are provided so that tenants can separate their paper and cardboard, plastics and glass and residuals. A cleaning contractor prepares residual materials for recycling.

Tenants may be asked to do a weekly self-audit of their residuals bin to see if waste can be further reduced. The building environmental manager provides education and advice for tenants to reduce residual materials going to landfill.

Results

Because they have a shared sense of involvement in the mission of applying the principles of sustainability to commercial buildings, tenants have responded well to both the Green Lease and the Environmental Management Plan.

The design of the building and the way its systems operate empower tenants to control both the environmental impact of their workplace and the comfort of their working environment.

60L hopes to facilitate the greening of commercial buildings by providing the guideline and framework plans so that environmental efficiency can be built into company practice, not just building design.

PRODUCTIVITY

Another impact is expected to be the productivity benefit for those working in 60L.

Studies of workplace environments have indicated the probability of a very real relationship between the physical and mental performance of people and the built environment in which they operate.

Several overseas studies have put the benefits at between 5-15% productivity improvement per occupant.



If 60L can achieve this for its tenants the commercial benefit will be many times greater than the dollars from energy savings.

A joint study by the [U.S. Department of Energy](#) and the [Rocky Mountain Institute](#) found that sustainable workplace design could result in spectacular worker productivity gains.

In one case study, Pennsylvania Power and Light, after introducing an energy efficient, quality lighting system which cut annual operating costs by 73 per cent, reduced absenteeism by 25 per cent. At the same time, worker productivity increased by 13 per cent. According to the study, the return on investment for the company in question - including savings associated with reductions in errors and improved employee health - was beyond 1,000 per cent.

With regard to Occupational Health & Safety, a direct link can be made between employee comfort and health. The 60L building has been designed to create a healthy working environment. Many of the factors that contribute to so called 'sick building syndrome' - air conditioning cooling towers, off-gassing fabrics, volatile adhesives, PVC products and particle boards, and a wide range of other materials - have been reduced or eliminated.