Greening Your Building

A Toolkit for Improving Asset Performance

city of Melbourne

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"Greening Your Building – A Toolkit for Improving Asset Performance" was produced with the assistance of:

Sustainable Built Environments P/L www.sbe.com.au

Australian Institute of Refrigeration, Air Conditioning and Heating (A.I.R.A.H.) www.airah.org.au

Introduction

Greening buildings in the City of Melbourne is an important step in saving water, waste and energy in a time of changing climate. The City has been working with office buildings, hotels, high rise residential apartments and food businesses to help make these changes. Through these projects, it is clear that there is a need for simple information to be provided to building owners and operators about ways to improve environmental performance through operation and maintenance procedures.

It is in response to this need in our *Building Improvement Partnership Project (BIPP)* with commercial office buildings that the City of Melbourne has partnered with AIRAH to deliver *Greening Your Building – A Toolkit for Improving Asset Performance.* The Guide has been designed as a single starting point for making office buildings green.

Greening Your Building – A Toolkit for Improving Asset Performance presents a number of environmental opportunities for building owners and facility managers to use in managing their building. Information is provided to make informed decisions on integrating environmentally sustainable development (ESD) into building maintenance, management and refurbishment plans.

DEFINITION OF STAGES

A Management

Management encompasses the policies and practises of running a business. Management directives, priorities and policies play a vital role in ensuring environmental actions play a central role in the culture of an organisation.

B Maintenance

Maintenance involves general activities undertaken on a regular basis to retain a building's appearance and keep it running efficiently. In the context of this toolkit, building maintenance is focused on improving the performance of a building in terms of its resource efficiency and the quality of the indoor environment.

Generally, a Building Manager will consider long term maintenance issues as part of a Maintenance Plan that factors in regular schedules for various elements of building plant and equipment. Building permits are not required for maintenance activities. Maintenance provides a good opportunity for replacing outdated systems over time. In a well managed building, maintenance schedules are informed by an Assets List and Essential Services List.

Assets List

- Used for maintenance and to show building owners what is included in their property
- Identifies assets within the building eg: Fire Equipment - fire extinguishers, hose reels, fire doors, hydrants, etc
- Maintenance contracts are organised based on this list eg: 3 year valve overhaul, annual flow tests (independently monitored), pressure tests
- Operates on life cycle principles – 10 years in advance to give building owners an idea of cash flow
- E.g. Simplex fire panel is nearing 10 years in service, a recommendation is made that this should be replaced in the next few years and the costs factored into the Repairs and Maintenance Budget (R&M budget). Redundancy of equipment therefore presents an excellent opportunity to consider new more efficient technologies and systems.

Essential Services List

- Building Managers check-off list – fire services, sanitary, etc

C Refurbishment Level One

Refurbishment Level One is primarily concerned with appearance and immediate payback. It is often undertaken in response to an unplanned circumstance, such as a tenant vacating a space, and the subsequent need to attract and engage new tenants.

Very often service upgrades are not included at this level. This type of refurbishment often occurs on a floor by floor basis and, unless there is an overall strategy for a building, may need to be done on a regular basis.

Minor refurbishments do not require building permits, however, they do require the approval of the Building Manager who must review and approve refurbishment plans, especially if the Base Building is to be affected. Minor service upgrades can easily be included in low level refurbishments, though this is rarely done. To encourage minor service upgrades that consider ESD there needs to be a shift in industry thinking from providing a cosmetic solution to actually creating a space that inspires productivity and retains tenants.

D Refurbishment Level Two

Refurbishment Level Two work often falls under the capital expenditure budget and may involve upgrades to foyers and changes to office layouts. These changes very often relate to a loss of a tenant and the need to provide a “new look” to attract new tenants. Rising market awareness of ESD and internal air quality issues will continue to increase the likelihood of minor service upgrades being included at this level.

USING THE TOOLKIT

The main consideration in developing Greening Your Building was to reflect the way in which Building Managers go about their work. ESD opportunities have therefore been grouped by building system.

For each opportunity the following data is presented:

Benefits:	ESD benefits that may result.
Risks:	Factors that could threaten success.
Process:	Steps to evaluate and implement the opportunity.
Opportunities:	A list of specific opportunities that may be considered.
Costs:	Indicative installed cost. (2007 prices)
Payback:	Economic payback based on typical tariffs.
Resources:	References, web links and Green Star clauses.

Where applicable, the process or methodology for implementing a particular opportunity is provided. Links to further resources / information pertaining to each ESD element and what professionals may be of assistance are also provided when possible.

The toolkit is introductory rather than comprehensive with the aim being to identify opportunities that are relevant to particular stages of a buildings ongoing management and refurbishment

E.g. “I am renovating a tenancy – What opportunities are there to improve energy efficiency and occupant satisfaction?”

Green Star

The Green Building Council of Australia (GBCA) have developed the Green Star rating system which recognises environmental excellence in buildings. Throughout Greening Your Building a Green Star reference is provided for each element where relevant.

Green Star has released a pilot tool to assess the potential for sustainability in existing office buildings. We recommend that the Greening Your Building guide be linked in with this methodology to encourage building owners and managers to consider the whole Building Life Cycle, and be conversant with this when they undertake more major refurbishment projects.

Appendix A presents another view of the toolkit, based on ESD category.

RESOURCES

Green Building Council of Australia www.gbca.org.au

Australian Institute of Refrigeration, Air Conditioning and Heating (A.I.R.A.H.) www.airah.org.au

City of Melbourne www.melbourne.vic.gov.au/environment

Building Improvement Partnership Programme (B.I.P.P.)
www.melbourne.vic.gov.au/info.cfm?top=218&pg=3700

General

Maintenance Plan

GEN - 01

A maintenance plan defines a structured approach to optimising the performance of the building and its services, in terms of life, reliability and efficiency. By considering environmental impacts in this plan, better ESD outcomes can be achieved.

BENEFITS

The efficiency and performance of a building can be improved through the implementation of a maintenance plan that incorporates provisions for monitoring, commissioning processes, and maintenance.

To gain a basic understanding of the building's operations, a number of audits (energy, water, waste) should be undertaken to identify where the building sits with regard to environmental performance. This will allow for strategies to be developed to optimise its performance over time.

RISKS

The success of Maintenance Plans is threatened by an insufficient allocation to time or budget for the Plan to be enacted. The steps involved in the Plan need to be carried out in full and in sequence. Ideally a continuity of personnel should be maintained between steps to improve the chances of identifying patterns: both cause and effect.

The adage "you cannot manage what you cannot measure' applies. A successful maintenance plan requires measured outcomes to enable patterns to be tracked and performance assessed. If proper metering and monitoring strategies are not implemented then the plan's effectiveness will be limited.

PROCESS

Building Management to prepare a maintenance plan that details maintenance processes, and who holds the responsibility for them. The following areas should be covered:

- Air-conditioning maintenance
- Water systems maintenance – taps and fittings, flushing units, pumps
- Fire systems maintenance
- Building Management and Control System

COST

Included within base management of building

PAYBACK

Well maintained plant and equipment will presumably run at a greater efficiency and will have an extended life.

RESOURCES

AIRAH Manual DA19: HVAC&R Maintenance.

Green Star Technical Manual – Office Design v2: MAN-1

Long Term Maintenance Contracts

GEN - 02

Negotiate long term maintenance contracts for each major system within the building to ensure plant is kept in peak operating condition.

BENEFITS

Maintenance staff build up a body of knowledge about the system.

Condition of plant can be monitored giving advance warning of breakdown.

RISKS

Maintenance staff can become set in their ways and fail to pick up opportunities for improvement. It is important to develop maintenance log sheets that require staff to measure & record data rather than just ticking OK.

PROCESS

Develop an Asset Register listing equipment & location.

Develop a building-specific maintenance specification for each major system.

Install instrumentation to indicate system performance.

For air-conditioning consult the AIRAH guidelines.

Regular water program maintenance.

Review maintenance procedures & performance.

COST

Call for tenders based on specification.

PAYBACK

Unknown.

RESOURCES

AIRAH Manual DA19: HVAC&R Maintenance

City West WaterMAP™ www.citywestwater.com.au/business/watermap_program.htm

Carruthers, P.J., “Energy management through maintenance”, AIRAH Journal, Volume 49, Issue 9, 1995. www.airah.org.au/downloads/1995-09-01.pdf

Elms, L.D., “Maintenance - A Controlled Waste of Energy” AIRAH Journal, Volume 40, Issue 9, 1986. www.airah.org.au/downloads/1986-09-01.pdf

Price, B., “Maintenance for Energy Efficiency and Ongoing HVAC System Tuning”, Ecolibrium Journal AIRAH April 2007. www.airah.org.au/downloads/2007-04-01.pdf

Re-Commissioning - Tuning

GEN - 03

Commissioning is the process by which building services are tested to prove that they meet the specified performance criteria. For example an air balance shows that the correct air quantity is being delivered to each space.

Re-commissioning involves going back to check that each system is meeting the current requirements.

BENEFITS

Improved performance of building services systems: comfort, IEQ, energy efficiency.

RISKS

Commissioning is often a weak point in the handover of buildings as it is usually constrained by time. If not carried out with close reference to the design intent buildings can be handed over running at less than optimum and contrary to design intent. Later modifications and 'tweaks' instigated to fix poor performance stemming from poor or incomplete commissioning may contribute to the widening gap between design intent and building performance.

When buildings are not operated as the design intended then many of the predictions about building performance, for example energy consumption (ABGR), thermal comfort, fresh air rates etc will become invalid.

When building tuning and re-commissioning is carried out it is essential to identify original design intent and seek to return the systems to their originally intended operational state, unless building modifications or occupant behaviours demand a change.

PROCESS

To verify that the current system operates as intended by the designers, tests are required to determine: airflow through ducts, pressure on filters, coils and other components, temperature measurements and electrical readings.

Include clauses within internal Building Approvals process such that the modification of partitions within tenancies involves the re-commissioning of air and /or water distribution systems.

Include provisions in the Essential Services Checklist that the replacement of air-conditioning plant will require complete re-commissioning of the building.

COST

Allow $5,000 to $30,000.

PAYBACK

Difficult to quantify.

RESOURCES

ASHRAE Guideline 1 – 1996 – The HVAC Commissioning Process www.ashrae.org

CIBSE Commissioning Code M: Commissioning Management www.cibse.org

Green Star Technical Manual – Office Design v2: MAN-2

DHS commissioning guide

www.capital.dhs.vic.gov.au/capdev/CommissioningFacilities/

Defence step by step commissioning guide -www.defence.gov.au/im/commissioning/main.htm

Building Management Control System

GEN - 04

Building Management & Control System (BMCS) enables centralised control of building services including mechanical, electrical, fire and security.

A monitoring program can be used to identify energy consumption trends. It can be used to identify systems running inefficiently, or in unintended ways and in so doing, find areas for energy savings.

e.g. many systems adjust the supply air temperature based on the zone with the highest cooling demand. If one zone has insufficient supply air compared to its loads it will often be calling for cooler air, wasting energy. A BMCS can be programmed to detect this situation.

BENEFITS

Automate building operation

Assist with internal monitoring

Enable ESD control strategies (see HVAC - 06 to 11)

Record and derive performance data for assessment and reporting

RISKS

A BCMS is only as good as the data that enters it and the skill of the person who operates and interrogates it. Whilst a good BCMS can bring great value to building management a poorly set up BCMS may bring complexity and frustration.

Control algorithms are used by the BCMS to automate building operation and if the BCMS is not understood then building automation can become a liability rather than an asset.

PROCESS

Determine what is to be monitored, reporting time frames, responses

Requires sub-metering to be in place (EL – 03)

Develop reports that will enable systems to be tuned.

COST

Costs will vary widely depending on status of BCMS.

Sub-metering, provide extra point on BMCS: $1,500 to $3,000.

PAYBACK

Unknown.

RESOURCES

Mustafa, H. T.; Bansal, P. K., “Building Management Systems: Beyond Electronics”, Ecolibrium, AIRAH Journal, Vol.1, No. 4, 2002. www.airah.org.au/downloads/2002-05-02.pdf

Green Lease

GEN - 05

A “Green Lease” is an emerging concept that brings ESD issues into the leasing agreement between owner and tenant.

To help government meet its energy targets set in the Energy Efficiency in Government Opperations policy, green lease schedules have been developed where the rent is gross and the net lettable area of the premises are 2000 square metres or more.

BENEFITS

To ensure a work environment that optimises the indoor environment quality while reducing the environmental impacts on the outside environment a green lease can be prepared that details:

- Energy, water and waste reporting commitments.
- Green cleaning initiatives
- Green purchasing/consumables

RISKS

None known.

PROCESS

Agree on the key ESD issues to be covered in the lease.

Develop and document responsibilities of both parties.

Implement.

Review.

COST

Unknown

PAYBACK

Indeterminate

RESOURCES

Investa, “Green Lease Guide for commercial office tenants”, Investa Properties Limited, 2006.

www.greenhouse.gov.au/government/publications/eego.html

Gross Lease

GEN - 06

Gross lease means a property lease in which the landlord agrees to pay all expenses which are normally associated with ownership, such as utilities, repairs, insurance, and (sometimes) taxes.

Net lease means a property lease in which the lessee agrees to pay all expenses which are normally associated with ownership, such as security, cleaning, air-conditioning, maintenance, utilities, insurance, taxes and often statutory costs such as land tax It can also be called a closed-end lease. Double and triple net leases are variations of this.

BENEFITS

Which type of lease does the market prefer?

In both a normal market and a soft market, gross leases are preferred by;

- Landlords: Can prefer gross leases because they can compete in the market place on gross lease prices. If they then operate the building efficiently they will not only save on costs, but also reduce the difficulty in recovering outgoings from tenants.
- Lessees: May prefer gross leases because they know what their costs are going to be and can budget for them. However, since they may not have the skill set to operate the building efficiently and benefit from lower running costs, they are usually covered for quality of services in the building by special provisions in the lease.

ESD and lease types

With respect to ESD, gross lease are preferred because;

- Lower operating costs should result because those looking after the building are more skilled at reducing costs and emissions.
- Landlords can take a long term view and invest with respect to ESD. Net leases have some advantages as it links use with the user, encouraging lessees to be more mindful in their energy use practices.

RISKS

Under a gross lease the landlord pays all outgoings, so the tenants incentive to adjust their behaviour is reduced. Tenant behaviour to be encouraged may include switching off lights and equipment, operating blinds, reporting unusual operation (plant left on) etc.

PROCESS

The type of lease is decided when a space is first leased and then at each review.

COST

Unknown

PAYBACK

Indeterminate

RESOURCES

The Property Council of Australia: www.propertyoz.com.au/

Occupant Satisfaction

GEN - 07

Survey the building occupants regarding their satisfaction with their indoor environment.

BENEFITS

The indoor environment quality can have a significant impact on the health, well being and satisfaction of the building's occupants which in turn has an impact on worker productivity, sick days taken and staff retention.

According to the Australian Greenhouse Office,

"…For every dollar you spend on energy, you probably spend around $20 on staff salaries".

Therefore it is in the organisation's interest to ensure that their workers are happy with their surroundings and that their needs are being met.

RISKS

If issues identified in the survey are not addressed then occupants will see the exercise as a waste of time.

PROCESS

A survey should be developed that covers occupant thermal, acoustic and visual comfort and their satisfaction with heating, cooling, ventilation, lighting, humidifying systems etc. The survey should be completed at regular intervals (e.g. annual) with a sample group of staff, the results collated and an action list compiled. A mechanism needs to be implemented to ensure that the issues raised are addressed by the appropriate person within an appropriate timeframe.

COSTS

Costs will include survey preparation, time for participants and data analysis and reporting.

PAYBACK

Indeterminate

RESOURCES

National Australian Built Environment Rating System (NABERS) Occupant Satisfaction measure: www.nabers.com.au

Post-occupancy Probe studies: www.usablebuildings.co.uk/

BREEAM Office 2006 Operation and Maintenance – Credit HW21 & 22.

Leaman, A.; Bordass, B, "Productivity in Buildings: The "Killer" Variables", in 3 parts Ecolibrium Journal AIRAH 2005.

Part 1 www.airah.org.au/downloads/2005-04-01.pdf

Part 2 www.airah.org.au/downloads/2005-05-01.pdf

Part 3 www.airah.org.au/downloads/2005-06-01.pdf

Leaman, A.; Thomas, L.; Vandenburg, M, "Green' Buildings: What Australian Building Users Are Saying" Ecolibrium Journal AIRAH Nov. 2007
www.airah.org.au/downloads/2007-11-01.pdf

Building User's Guide

GEN - 08

A Building User's Guide is a document aimed at occupants and tenants representatives. As well as functional and safety considerations, the guide should cover ESD issues from the tenants perspective.

BENEFITS

A Building User's Guide that details the systems with which the building users, occupants and tenants will interact will provide better performance outcomes.

This document can also be used to provide guidance on how the building's performance can continue to be optimised through monitoring and improvement.

RISKS

A Building User's Guide is useful only if it is well set out, uses layman's terms, covers all of the information necessary to understand the building and its systems and is provided to all occupants and tenants. User training is usually required as well.

When building systems are updated and modified the Building User's Guide must be updated. An out of date manual can be counter productive.

PROCESS

Building Owner / Manager to prepare Building User's Guide based on initial audits of the building. The guide should include information on:

- Energy and Environmental Strategy,
- Monitoring and Targeting,
- Building Services,
- Transportation Facilities,
- Materials and Waste policy,
- Expansion / refurbishment / refit considerations,
- Building Owner to provide to tenants as part of tenancy agreement

COST

$2,000 to $5,000

PAYBACK

Indeterminate

RESOURCES

Green Star Technical Manual – Office Design v2: Man-5, Building User's Guide

Green Star Office Interiors, Man-4, Tenant Guide

Building Conservation

GEN - 09

Adaptive re-use of existing buildings is to be encouraged as a sustainable way to reduce resource use.

BENEFITS

Commercial construction and demolition waste accounts for around 33% of all waste disposed to landfill in metropolitan Melbourne.

GreenStar encourages that buildings be revised where possible as the embodied energy and water in new buildings are greater than those in re-used buildings.

RISKS

Retention of an existing façade and structure may require extensive reinforcement and renovation.

PROCESS

The largest savings in the use of new materials come from the reuse of a buildings façade and major structural elements (floors, column, beams, load bearing walls and foundations) in a refurbishment. Where possible, other building elements should be retained or reused to reduce material use.

COST

Reuse of existing materials and structures will cost less than new materials.

PAYBACK

Immediate.

RESOURCES

www.ecorecycle.vic.gov.au

Green Star Technical Manual – Office Design v2: Mat-2, Mat-3.

Asbestos Removal

GEN - 10

Asbestos, a carcinogenic mineral fibre, was used in thermal insulation, sound-proofing, partitions, roof materials, ceiling tiles, fire-proofing etc. in buildings and structures up until the mid 1980s. If inhaled, asbestos fibres can cause mesothelioma, lung cancer, asbestosis and other potentially fatal diseases.

BENEFITS

The risk of asbestos affecting staff health is removed.

RISKS

Asbestos must only be removed from a building or structure by a Licensed Asbestos Removal Contractor.

PROCESS

During the refurbishment process, a survey should be undertaken to determine if there are any asbestos materials or products in the building. If so, it should be removed in accordance with legislation, by a licensed asbestos removal contractor.

COST

The cost of an asbestos survey is in the order of $750 for simple buildings and $6,000 for a high rise tower. Cost is dependent on the size and complexity of the structure, location, and requirements for specialist access equipment.

PAYBACK

Not quantifiable.

RESOURCES

Guide to the Control of Asbestos Hazards in Buildings and Structures, National Occupational Health and Safety Commission (NOHSC), 1988 www.nohsc.org

Green Star Technical Manual – Office Design v2: IEQ-11,

Office Interiors v1.1: IEQ-9, Office As Built v2: IEQ-11.

Energy Audit

GEN - 11

Reviewing the energy use of a building in order to make improvements.

BENEFITS

An energy audit can assist in improving the environmental performance of a building or tenancy by:

1. identifying areas where operational procedures can be made more efficient
2. demonstrating the need for plant and/or equipment to be replaced
3. providing a review of maintenance requirements

Average tenancy performance is considered to be between 424 and 523 MJ/m2 which is equivalent to 2 Stars. Current best practice is 3 Stars which is between 324 and 423 MJ/m2.

RISKS

The level of detail available will depend on how many meters are used to monitor energy use in the building. Older buildings may have only one meter.

PROCESS

Collect energy bills for a year

Gather site and building plans and specifications; plant and major equipment inventory: activity or production levels. Calculate average power use (kWh per m2) for working hours, lunch and after hours

Level 1 audit – overview of energy use, initial benchmark figures

Level 2 audit – energy sources and breakdown of uses identified, potential costs and savings identified

Level 3 audit – detailed analysis of use, detailed costings

COST

Allow 10 to 20% of annual energy costs depending on level of audit. $2,000 to $10,000.

PAYBACK

A good energy audit should identify energy savings of 20 to 30% with paybacks less than 3 years.

RESOURCES

Refer to www.abgr.com.au/downloads/guidelines.pdf for “Guide to collecting data”

Refer to Sustainability Victoria website for further information on different levels and costs of audits: www.seav.sustainability.vic.gov.au/advice/business/energy_management/energy_auditing.asp

Energy Target

GEN - 12

Setting a benchmark for energy use for a building or office is fundamental to saving energy.

BENEFITS

Setting a target for reducing energy use provides motivation for staff and provides a sense of achievement when reached.

Companies often use targets in promotional materials.

RISKS

The target should be realistic and achievable.

Care must be taken to compare “like with like”. E.g. What energy uses are included? How is the area measured? Has the target been adjusted for operating hours?

PROCESS

Developing a target for energy reduction in existing buildings involves the following steps:

- Review existing use through an energy audit.
- Calculate energy savings potential.
- Use the existing building best practice benchmarks of 558MJ/m2pa for direct electricity heating and 669 MJ/m2pa for gas heating as a guide.
- Calculate a custom target that considers what energy uses, operating hours.

COST

An energy audit costs $2,000 to $10,000.

PAYBACK

Not applicable.

RESOURCES

Property Council of Australia: Energy Guidelines

www.propertyoz.com.au

Water Audit

GEN - 13

A water audit is a review of the current water use of a building or occupant through an assessment of bills, practises and existing fittings.

BENEFITS

A water audit can provide an understanding of where, how, and how much water is used in a commercial office building. This will assist in developing a strategy for reducing its use.

NB Water audits are now regulated in Victoria for sites using more than 10 megalitres per year.

RISKS

The quality of information resulting from a water audit is largely dependant on the data available. Separate metering of large water uses can help pin-point specific problems and aid in tracking the results of improvements made.

PROCESS

Undertake water audit and technical review of water used at the site. This will assist in identifying old fittings and fixtures that need replacing and these can then be scheduled into the maintenance plan. The water audit should consider:

- Annual water bills,
- Types of fittings and fixtures,
- Shower use – note: the quantity of water used in showering is related to whether the building includes provision for cyclists,
- Occupancy rates and hours,
- Details of rainwater harvesting or grey water treatment,
- Calculate average water use (kL per m2 or person) for working hours, lunch and after hours.

A Walk Through of the building is useful to identify strategies for improvement in water used by physical observation of:

- where water is used;
- what is it used for;
- cleaning practices; and
- what are obvious water efficiency strategies.

COST

Private companies offering Water Audits will charge in the range of $150-$2,000 dependent on complexity. The Savewater! Efficiency Service offers a payback through savings option. There are also guidelines available to conduct a self-audit.

PAYBACK

Typical payback is 1 to 2 years.

RESOURCES

www.savewater.com.au
www.melbournewater.com.au
www.citywestwater.com.au
www.sewl.com.au
www.yvw.com.au
City West WaterMAP™ www.citywestwater.com.au/business/watermap_program.htm

Water Target

GEN - 14

Setting a benchmark for water use for a building or office is fundamental to saving water.

BENEFITS

Setting a target for reducing water use provides motivation for staff and provides a sense of achievement when reached.

Companies often use targets in promotional materials.

RISKS

The target should be realistic and achievable.

PROCESS

Developing a target for water reduction in existing buildings involves the following steps:

- Review existing use through an water audit
- Calculate water savings potential
- Use the existing building best practice benchmark of 0.75kL/m2 pa as a guide.

COST

A water audit costs $150 to $2,000.

PAYBACK

Not applicable.

RESOURCES

Sectoral Targets by City West Water, South East Water and Yarra Valley Water

www.citywestwater.com.au

www.sewl.com.au

www.yvw.com.au

Waste Audit

GEN - 15

A waste audit is a formal process used to identify and quantify the waste generated within an office building or tenancy. It can be used to establish how effective current waste practices are, how they can be improved, and to set targets for a Waste Reduction program

30,000 tonnes of waste is generated by office buildings in Western Region of Melbourne including the CBD every year.

BENEFITS

More effective use of resources.

Reduced waste management costs.

RISKS

If staff know in advance when an audit is to be undertaken, behaviour may be adjusted which may skew the outcome.

Training needs to be undertaken on a regular basis to continue to promote waste reduction programs.

Management support is important to allow audit to be undertaken and so that findings can be acted upon.

PROCESS

A waste audit consists of:

- monitoring the waste;
- reporting the results; and
- comparing results to best practice benchmarks.

COST

$1,000 - $2,000

PAYBACK

No significant return on investment direct to the owner.

RESOURCES

Wastewise - Office Kit and Resource Kit, Melbourne Network Group

GFA – Case study 140 William Street

Sustainability Victoria Physical audit checklist - www.sustainability.vic.gov.au/resources/documents/Guidelines_for_assessing_your_waste.pdf

www.wme.com.au/magazine/downloads/WasteAudit_oct2002.pdf

NSW Government Waste Reduction and Purchasing Policy www.wrapp.nsw.gov.au/download/wasteaudit.pdf

Waste Target

GEN - 16

Setting a benchmark for waste use for a building or office is fundamental to reducing waste.

BENEFITS

Setting a target for reducing waste use provides motivation for staff and provides a sense of achievement when reached.

Companies often use targets in promotional materials.

RISKS

The target should be realistic and achievable.

PROCESS

Developing a target for waste reduction in existing buildings involves the following steps:

- Review existing use through an waste audit,
- Calculate waste savings potential,
- Use the existing building best practice benchmark of 3.0 kg per employee per week as a guide.

COST

A waste audit costs $1,000 to $2,000.

PAYBACK

Not applicable.

RESOURCES

Wastewise - Office Kit and Resource Kit, Melbourne Network Group

www.sustainability.vic.gov.au

Australian Building Greenhouse Rating

GEN - 17

An ABGR is based on measured data and enables a building owner to quantify the energy consumption and greenhouse emissions of their building and to benchmark its performance against other buildings.

BENEFITS

Energy efficient buildings have lower running costs and produce less greenhouse gas emissions. They provide a financially competitive advantage to building owners and tenants.

ABGR has been developed so that office buildings or individual tenancies can be assessed and compared on their relative energy efficiency and greenhouse gas emissions.

The energy consumption range for each Star level is as follows

1 Star = 524 – 623 MJ/m2
2 Star = 422 – 523 MJ/m2
3 Star = 324 – 423 MJ/m2
4 Star = 223 – 323 MJ/m2
5 Star = less than 223 MJ/m2

ABGR provides official recognition for buildings that achieve 3 stars. A 3 star building is equivalent to current best practice.

RISKS

The ABGR tool can be used in a predictive fashion, as is the case with the Green Star tool. In such a case a combination of modelling and assumed tenant loads, hours of operation etc is used to simulate building performance. These simulations are useful but are unlikely to be entirely accurate when compared to actual consumption.

PROCESS

In order to complete an ABGR assessment an audit must be undertaken to determine energy consumption.

Energy bills are measured against the size of a building, number of occupants, hours of operation and equipment density.

The ABGR website provides a performance rating calculator, Star Performer, to determine the Star rating for the building.

COST

A certified ABGR rating costs between $1,000 - $4,000.

PAYBACK

Not applicable

RESOURCES

Refer to www.abgr.com.au to utilise the “Star performer” calculator.

Green Star Technical Manual – Office Design v2: ENE-1 and ENE-2

NABERS Office Water Rating

GEN - 18

NABERS OFFICE is a voluntary environmental rating system for existing office premises and includes a water calculator. The building is given a water rating on a scale of one to five stars (best practice).

BENEFITS

NABERS OFFICE ratings are based on actual data related to the performance of an office building over the previous year using real data.

The rating can be used to identify how the building performs compared to best practice and to other office buildings. This will allow realistic targets for reduced water use to be set.

RISKS

While the tool will benchmark your performance against other buildings, the tool does not point you towards any specific improvement options.

PROCESS

Water audit data is input into the NABERS office water calculator.

The calculator makes adjustments to suit the specific location of the office building. Adjusted data is compared with benchmark data and a rating score that reflects comparative performance is calculated.

COST

Self-assessment is free to do, an accredited rating will cost $2,000-$4,000.

PAYBACK

Not applicable

RESOURCES

www.nabers.com.au

Green Star Rating (GBCA)

GEN- 19

The Green Building Council of Australia's Green Star suite of tools are voluntary and are aimed at the top 25% of the building market. The environmental issues addressed by the tools are Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions and Innovation.

BENEFITS

The Green Star Certificates are highly regarded and achievement of a rating adds certainty to any environmental claims made.

The Green Star tools map environmental initiatives against performance benchmarks allowing the design team to compare performance goals within a set structure.

RISKS

The Green Building Council Office Design tool only apply to buildings that are occupied by 80% office space. Refurbishments may find it more difficult than new office buildings to achieve a certified rating.

PROCESS

To achieve a Green Star Certificate for a refurbishment of an office building during design (Office Design), post-construction (Office As-Built) or tenancy (Office Interiors) the following process must be followed:

- engagement of a Green Star Professional;
- assessment;
- registration;
- collection of evidence;
- submission and
- review and re-submission (usually required).

COSTS

The certification cost for a Green Star rating is between $7,500 and $15,000. The engagement of a Green Star Accredited Professional to aid the design team and complete the documentation can be anywhere between $20,000 - $50,000. There are also extra costs to other consultant team members.

The initial impact on construction costs of achieving a 4 star rating is 0%, 4 to 5 stars is 3-5% and 4 to 6 stars is 9-11%.

PAYBACK

Additional gross lease rental required to achieve 11% IRR for 4 to 5 stars is $19 and 4 to 6 stars is $40 /m2 NLA/pa.

RESOURCES

Davis Langdon, The Cost and Benefit of Building Green.

Green Star Technical Manual – Office Design v2. www.gbcaus.org

Cleaning

Cleaning

CL - 01

Some cleaning products contain toxic and non-biodegradable ingredients that contaminate the environment and endanger human health. Green cleaning involves selecting alternative products, using those products properly, and taking other steps to reduce risks while maintaining a satisfactory level of cleanliness and disinfection.

BENEFITS

Reduce the risk of skin irritation and maintain indoor air quality

Reduce the environmental impact of dyes

Reduce packaging and waste

Minimise exposure to concentrates

Healthier working conditions for cleaning staff

RISKS

Green cleaning products may be more difficult to source. The only Australian Standard that applies at present relates to biodegradability, standards relating to the other environmental impacts of cleaning products are needed before product choices will be easily made.

PROCESS

Select products that:

- are ready biodegradable
- are non-toxic, and
- contain no phenolic compounds or petroleum solvents.

COSTS

May cost marginally more than standard cleaning products but becoming equivalent.

PAYBACK

Difficult to quantify

RESOURCES

www.ecobuy.org.au/

www.aela.org.au/

www.greenpagesaustralia.com.au

Domestic Hot Water

Reduce DHW Demand

DHW - 01

Reduce the demand on the domestic hot water system in terms of the volume of hot water consumed, the temperature maintained and/or the time of day that hot water is supplied.

BENEFITS

Reducing the demand on the domestic hot water system will lead to energy and cost savings associated with that system. Domestic hot water use accounts for approximately 4 to 5% of overall energy consumption or 16% of gas consumption.

RISKS

Care must be taken to avoid the conditions that Legionella bacteria thrive under – namely stagnant regions at temperatures between 35 to 50°C.

OPPORTUNITIES

- Consider not supplying hot water to hand basins.
- Provide instantaneous hot water heaters (gas or electric) at remote locations.
- Water conserving dishwashers.
- Water efficient showerheads and tapware.
- Review domestic hot water distribution temperature. Operate at 60°C for one hour each day for Legionella control.
- Review schedule for hot water supply. Consider turning off hot water boiler early.

COSTS

Various

PAYBACK

Determine for each measure.

RESOURCES

www.greenhouse.gov.au/lgmodules/wep/toolkit/dhw.html

Reduce DHW Distribution Losses

DHW - 02

Reduces the likelihood of a DHW system losing heat on a continuous basis, regardless of whether any hot water is being used.

BENEFITS

Energy and cost savings.

RISKS

None

OPPORTUNITIES

- Install time clock or remote thermostat circulating pump control
- Improve insulation on water heaters and tanks (heater blankets)
- Add or improve insulation to hot water pipes and fittings
- Consider not supplying hot water to hand basins
- Provide instantaneous hot water heaters (gas or electric) at remote locations.

COSTS

Super pipe & ductwork insulation: $3 to $7/m2 of GFA. Nominal increase of thickness by 25mm.

PAYBACK

Varies

RESOURCES

Czarnecki, J.T., “The Economics of Thermal Insulation” AIRAH Journal, Vol. 22, No. 9, 1968.

Efficient DHW Generation

DHW - 03

Improve the efficiency of domestic hot water generation system.

Some buildings still have calorifiers connected to the heating system which then must be operated year round to supply hot water even when there is no heating load.

BENEFITS

Energy and cost savings.

RISKS

None

OPPORTUNITIES

- 90%-plus condensing boilers
- Provide a separate boiler for DHW, replacing calorifier
- Preheat DHW with reclaimed waste heat (e.g. chiller condenser, boiler stack economizer, 24/7 computer server room AC unit)
- Solar pre-heat cold water feed
- Heat pump water heater

COSTS

Solar-boosted water heater: $5,000 to $8,000 installed.

PAYBACK

Undertake feasibility and cost effectiveness study.

RESOURCES

Domestic Hot Water Toolkit:

www.greenhouse.gov.au/lgmodules/wep/toolkit/dhw.html

Electrical

Reduce Peak Electrical Demand

EL - 01

Reduce the demand on the electricity supply system at peak times.

BENEFITS

Reducing system demand at peak times reduces the need to extend generation and distribution capacity and improves generation system overall efficiency.

Cost savings due to peak demand reduction can be significant.

RISKS

Some strategies to reduce peak demand will use more energy.

OPPORTUNITIES

- Determine how long some or all chillers can be turned off before space temperatures rise to unacceptable levels.
- On hot days, pre-cool building by 1 or 2 degrees to extend time when chillers can be held out.

  Identify large sheddable loads and install automated controls to limit electrical demand
- Thermal energy storage – ice, phase change or chilled water.
- Investigate potential for on-site electricity generation – Is there an existing generator on site?

COSTS

Thermal Energy Storage: $10 to $30/m2 of GFA. Detailed feasibility study required to establish best option and determine viability.

PAYBACK

Feasibility study required

RESOURCES

Tamblyn, R.T., “Thermal Storage - Will Ice or Water be the Preferred Medium?”, AIRAH Journal, Vol. 42, No. 4, 1988.

Wilkinson, A.L., “Extending capacity of existing university chilled water system utilising satellite thermal storage”, AIRAH Journal, Vol. 53, No. 8, 1999.

Efficient Motors And Drives

EL - 02

High efficiency motors have lower losses than conventional motors by between 2 and 7%.

Variable speed drives (VSD) enable pump and fan speeds to be controlled to match the prevailing required flow rate. This can be an efficient form of balancing for constant speed plant or as an efficient means of providing variable flow rates.

BENEFITS

High efficiency motors consume less electricity than standard motors.

RISKS

Care must be taken with VSD selection and installation to avoid electrical interference to nearby circuits.

OPPORTUNITIES

- Premium-efficiency motors
- Variable-speed motor drives
- Elevator pump/motor efficiency opportunities

COSTS

Premium-efficiency motors: $1 to $2/m² of GFA extra for all motors in HVAC system.

Variable-speed motor drives: $3,000 to $5,000 each, installed.

PAYBACK

Medium.

RESOURCES

Anderson, K., “Variable Frequency Speed Control: Installation and Selection” AIRAH Journal Volume 45, Issue 2, 1991.

Sub-Metering – Energy

EL - 03

Sub-metering allows for a more accurate understanding of where, when and how much energy is being used.

BENEFITS

Allows the collection of data on major energy uses within a building for easy historical analysis.

Enables early detection of operational problems.

Makes it easy to identify energy saving solutions and quantify the benefits.

RISKS

Sub-metering results should be communicated to users.

PROCESS

Install sub-metering to systems or areas that use substantial amounts of power (100kVa).

Sub-metering should also be provided to each tenancy.

Develop a monitoring regime to collect and analyse metered data.

Provide feedback to tenants, staff who control or maintain the monitored equipment.

COSTS

Sub-metering, provide extra point on BMCS: $1,500 to $3,000.

PAYBACK

Often less than one year.

RESOURCES

Green Star Technical Manual – Office Design v2: ENE-3 and ENE-4

Energy Conservation

Reduce Heat Losses

EN - 01

Heat loss is the fastest through glazing and then any uninsulated ceiling, walls and floors of a building.

BENEFITS

Reduced heat loss results in winter heating energy savings.

Reduce heat loss can result in a more comfortable environment for users.

RISKS

Means of removing heat in summer in a controlled manner should also be considered.

OPPORTUNITIES

Install or upgrade insulation to:

- Ceiling/roof,
- Walls and spandrel panels,
- Floor above unconditioned space or carpark,
- Metal window frames.

If replacing windows:

- Consider double glazing
- Select window frames for reduced heat loss.
- High-performance low-e coating

COSTS

Insulation cost $10-15 per m2.

Extra cost of high performance glazing: $16 to $24 per m2 of glazing.

PAYBACK

The payback will depend on the installed heating and cooling systems and is estimated as 3 years for the first installation of insulation.

RESOURCES

Green Star Technical Manual – Office Design v2: ENE-02

www.sustainability.vic.gov.au

Reduce Heat Gain

EN - 02

Reducing heat gain through the building fabric, due to heat conduction and solar gain.

BENEFITS

Savings in cooling energy and cost.

Savings in peak demand.

Reduced discomfort to occupants near the façade.

Reduced discomfort due to cold air “dumping” in internal zones.

RISKS

None

OPPORTUNITIES

- Install or upgrade insulation.
- Architectural shading and overhangs.
- Exterior building shading - trees and plants.
- Reduce glazed area – convert some windows to insulated spandrels.
- Tinted glazing or reflective coatings.
- Reflective Film on windows.
- Select new internal blinds for solar control.
- High reflectance roof paint (if uninsulated).

COSTS

Insulation cost $10-15 per m2.

Extra cost of high performance glazing: $16 to $24 per m2 of glazing.

Timber window frames: $350 to $450m^2 of window area. Assumes timber windows in low level building situation; and full replacement of window (cost excludes removal of existing and make good).

High-performance low-e coating: $52 to $85 m^2 of window area.

Architectural shading and overhangs: $300 to $1,500 m^2 of sun shade.

Exterior building shading - trees and plants: $200 to $300 per tree. (Semi mature tree in landscaping zone: cost of landscaping zone excluded)

Select new internal blinds for solar control: $150 plus per m^2 of glazing area. Base: Surface mounted aluminium venetian blinds.

PAYBACK

The payback will depend on the installed heating and cooling systems.

Around 3 years for the first installation of insulation. Improved glazing can have a payback of less than 2 years.

RESOURCES

Green Star Technical Manual – Office Design v2: Ene-1.

Reduce Infiltration

EN - 03

Infiltration is the uncontrolled leakage of outside air into the building.

BENEFITS

Savings in heating and cooling energy and cost.

Reduced discomfort to occupants near the leakage points.

RISKS

None

OPPORTUNITIES

- Blower door test, seal envelope leaks.
- Seal openings at penetrations of building envelope.
- Create air lock at main entrance.
- Install doors/seals in loading dock areas.
- Wind protection of external doors.

COSTS

Create air lock at main entrance: $15,000 to $35,000. (Assumes no major structural modifications.)

Door and window seals cost $10-20 per opening.

PAYBACK

Low for door and window seals.

RESOURCES

Air Infiltration & Ventilation Centre: www.aivc.org/

External

Landscape & Water

EX - 01

Landscape water use is a small proportion of the total in a commercial building. However, there are many opportunities to reduce the potable water at minimal cost.

BENEFITS

Reduced potable water use.

Waterwise planting.

Decreasing the impermeable area of the site reduces peak stormwater flows and nutrient loading.

RISKS

The ongoing maintenance cost of a rainwater collection system

OPPORTUNITIES

- Landscape irrigation water efficiency - sub-surface watering, soil moisture sensors.
- Indigenous or drought tolerant plant selection
- Roof gardens
- Underground Storage tanks
- Rainwater harvesting
- Water recycling

COSTS

Sub-surface drip irrigation system with soil moisture sensors:

Above Ground Storage tanks: $17,000 to $22,000. Assumes 3450 x 2300 high concrete storage tank; above ground (no allowance for reticulation) Also excludes shielding / fencing.

PAYBACK

Immediate for drought tolerant plant selection, within one to two years for an efficient irrigation system and high for rainwater reuse.

RESOURCES

Green Star Technical Manual – Office Design v2: WAT-3

www.savewater.com.au

Fire

Fire Protection

FI - 01

Sprinkler systems for fire protection must be tested regularly, which can result in large volumes of water going to waste. This water can be conserved by recycling or providing holding tanks.

BENEFITS

Water savings.

RISKS

Tanks can be designed to be combined with a rainwater collection system but should be designed with enough capacity to hold the required fire testing water plus any additional water incoming from rainwater so that no water is lost.

PROCESS

Check current regulations to ensure that tests are not conducted too frequently.

Determine water consumption during fire tests and develop strategy for retaining water for re-use.

Commonly the water is reused in toilet flushing, cooling towers or irrigation.

COSTS

Storage and reuse of test water: $50,000 to $70,000.

PAYBACK

Greater than 20 years.

RESOURCES

Green Star Technical Manual – Office Design v2: WAT-5

Heating Ventilation & Air Conditioning

Air Handling System Upgrade

HVAC - 01

When replacing or upgrading air handling systems consider the following opportunities.

BENEFITS

These measures can lead to improved energy efficiency, improved thermal comfort in occupied spaces and more flexible operation after hours.

RISKS

None

OPPORTUNITIES

- Specify efficient fans and select efficient size fan wheel.
- Separate HVAC units for perimeter and core zones.
- Change constant air-volume reheat to Variable Air Volume (V.A.V.) reheat.
- Change multi-zone or dual duct to V.A.V..
- Isolate areas with extended hours or thermal requirements by zoning and programming V.A.V. terminal boxes or install dedicated HVAC system.
- Parallel fan-powered V.A.V. boxes to reduce perimeter zone reheat using heat from lights.
- Convert multi-zone or dual duct to variable air volume.
- Consider displacement ventilation system, particularly for tall spaces or access flooring.
- Exhaust Air Heat Recovery.
- Insulate air ducts in unconditioned spaces.

COSTS

Commission a HVAC engineer or boiler specialist to determine feasibility and cost effectiveness.

Replace inlet guide vanes or by-pass dampers with Variable Speed Drives: $4,000 to $7,000. Based on 7.5kW motor.

PAYBACK

Varies.

RESOURCES

Croft, G., “Energy System Optimisation”, AIRAH Journal, Vol.45, No. 4, 1991.

Ebers, W., “How to make energy savings with variable speed drives”, AIRAH Journal, Vol. 54, No. 1, 2000.

Boilers – Replace / Upgrade

HVAC - 02

When replacing heating hot water boilers consider the following opportunities:

BENEFITS

Reduced heating fuel consumption with associated operating cost savings.

RISKS

None

OPPORTUNITIES

- vInstall multiple high-efficiency condensing boilers
- Replace and resize boilers for efficiency
- Central plant vs. satellite boilers: For larger heating hot water systems there is a balance to be struck between better part load efficiencies available in larger boilers and heat losses in large distribution systems. This balance will decide the viability of central plant vs. satellite boilers.
- Alternative heating sources: reverse cycle chillers, condenser heat reclaim, water or ground source heat pumps.

COSTS

Commission a HVAC engineer or boiler specialist to determine feasibility and cost effectiveness.

PAYBACK

Varies.

RESOURCES

www.greenhouse.gov.au/lgmodules/wep/toolkit/boiler.html

Boiler System Efficiency

HVAC - 03

Existing boilers can be modified and/or tuned up to use less fuel for heating. In Melbourne's temperate climate heating is fighting cooling. Any control shortcoming, e.g. leaking valves or dampers, can be the cause. To reduce this risk, vary HHW temperatures or switch off boilers after the building has warmed up.

BENEFITS

Reduced heating fuel consumption with associated operating cost savings.

RISKS

None

OPPORTUNITIES

- Non-modulating burner, specify low-high-low burner controls.
- Modulating burner control, specify high turn-down ratio. (>5:1)
- Improve draft controls: turbulators, barometric dampers.
- Improve combustion by reducing excess air with O2 trim controls .
- Boiler flue heat recovery to preheat domestic hot water cold feed.
- Vary HHW temperature with load (or ambient temperature).
- Improve water treatment to eliminate heat exchanger fouling.
- Isolate off-line boilers.
- Shut down large boilers in summer and use small ones.
- Switch off boilers after morning warm-up.
- Replace domestic hot water calorifiers with DHW boilers so that heating boilers may be switched off when there is no heating load.

COSTS

Commission a HVAC engineer to determine feasibility and cost effectiveness.

PAYBACK

Short to medium.

RESOURCES

www.greenhouse.gov.au/lgmodules/wep/toolkit/boiler.html

Chiller Efficiency

HVAC - 04

The efficiency of the chiller system can be improved by matching the supply of chilled water to the prevailing demands of the building. This may be possible by modifying the control logic of the BMCS.

BENEFITS

Reduced energy consumption and cost.

RISKS

Changes to the control system need to be made systematically and analysed to avoid discomfort problems if insufficient cooling is provided.

OPPORTUNITIES

- Optimise sequencing of multiple chillers - run most efficient combination for each load range.
- Isolate off-line chillers and cooling towers.
- Reset chilled water temperature upwards as cooling load reduces. Balance against increased pump energy in a system with variable speed pumps.
- Reduce condenser water temperature. Consult chiller manufacturer regarding acceptable range and benefits.
- Switch off chillers one hour before air handling systems to use the thermal “momentum” in the system.
- See Controls – Cooling (HVAC -07 & 08) for more ideas on reducing loads on the system.

COSTS

Low

PAYBACK

Short

RESOURCES

Crozier, B., “Enhancing the Performance of Oversized Plant”, BSRIA Application Guide AG1/2000.
www.greenhouse.gov.au/lgmodules/wep/toolkit/chiller.html

Archibald, J.; Gavelis, M., “Economies of Selecting Air Cooled Versus Water Cooled Refrigeration Equipment”, Ecolibrium, AIRAH Journal, Vol.1, No. 2, 2002.
www.airah.org.au/downloads/2002-03-02.pdf

Chiller – Replace / Upgrade

HVAC - 05

When a new chiller is required due to older plant being retired or load increases within the building, an opportunity to improve the chiller system efficiency arises. The match of existing plant being retained (if any) to the seasonal variations in chilled water load should drive the decision process.

BENEFITS

The improved "Coefficient of Performance" available in modern chillers translate into substantial energy savings and operating cost savings due the energy and maximum demand reductions.

RISKS

Interruption to chilled water supply. Schedule for cooler weather.

OPPORTUNITIES

- Select efficient kW/ton chillers: 1) centrifugal, 2) screw, 3) reciprocating
- Select chiller size(s) for efficient part load operation. Analyse frequency of operation at each part load range for the chilled water system.
- "Right size" the new chiller - Don't just replace like with like.

Alternate source of cooling:

- Heat recovery chiller
- Water, phase change or ice thermal storage system. Consider a small thermal store to prevent short cycling of a single chiller.

COSTS

Chiller suppliers can quote on high efficiency chillers.

Select efficient kW/ton chillers: $1 to $2/m^2 of GFA. OR 4% to 6% cost premium on chillers to achieve some 20% drop in electrical power.

Select chiller size(s) for efficient sequencing: $1 to $4/m^2 of GFA. Premium for new plant, cost to add low load chiller.

PAYBACK

Unknown.

RESOURCES

Deng, S., "Sizing Replacement Chiller Plants", ASHRAE Journal, June 2002.

Knight, I. and Dunn, G., "Size Does Matter", Building Services Journal 08/04.

Younes, A and Carter, G, "Internal heat load allowances – is more actually better?"

Controls – Air Handling

HVAC - 06

Air Handling Unit controls systems control the operation of the AHU in terms of ON-OFF times, fresh air controls and variation of air flow and/or temperature to efficiently meet the varying heating and cooling loads within the building.

The control systems can be tuned to match the current requirements of the area served and/or refined by adding new control algorithms.

BENEFITS

Improved comfort within the space served and savings in energy consumption and cost.

RISKS

It is important to only change one setting at a time and evaluate performance to ensure benefits are captured.

OPPORTUNITIES

- Air handling unit optimal start/stop
- Close Outside Air dampers when unoccupied and during start-up
- Duct static pressure reset - VAV air system
- Reduce outdoor air using CO2 sensors
- Reset supply air temperature
- Airflow reduction in unoccupied areas (occupancy sensors or scheduled)

COSTS

Various

PAYBACK

Often low cost. Benefit varies.

RESOURCES

Carpenter, S.C., “Energy and IAQ impacts of CO2 based demand-controlled ventilation”, Ecolibrium, AIRAH Journal, Vol. 52, No. 1, 1998.

Controls - Cooling

HVAC - 07

Controls on the cooling system can be adjusted or installed to improve the overall efficiency of the system.

BENEFITS

Savings in energy consumption and cost.

RISKS

It is important to consider the impact on all elements on the cooling chain to ensure the overall result is optimised. i.e. Fans, pumps, chillers and cooling towers.

The resulting control strategy must be robust enough to handle the range of ambient conditions experienced.

OPPORTUNITIES

- Chiller condenser water temp reset (off outdoor air wet bulb temp) or adjust cooling tower fan thermostat. Reducing condenser water temperature generally saves energy overall.
- Cold Deck Temp Reset.
- Integrated economizer controls. (see HVAC – 08)
- Night flush pre-cooling.
- Optimize sequencing of multiple chillers for part-load efficiency.
- Reset chilled water temperature based on cooling loads or outdoor air temperature.

COSTS

Commission a HVAC engineer to determine feasibility and cost effectiveness.

PAYBACK

Various

RESOURCES

Gupta, V.P., “Energy Conservation in Refrigeration Systems - Centrifugal Chillers”, AIRAH Journal, Vol. 42, No. 3, 1988.

Ahmed, A., “Advanced chiller optimal control”, Ecolibrium, AIRAH Journal, Vol. 48, No. 3, 1994.

Controls – Economy Cycle

HVAC - 08

An outside air economy cycle uses up to 100% outside air at times when cooling is required, to reduce mechanical cooling requirements.

In Melbourne up to 75% of normal operating hours occur when ambient temperatures are less than 20°C.

BENEFITS

Energy savings are achieved through the reduced operation of the mechanical cooling systems. Under mild ambient conditions (say 16 to 24°C) loads on the cooling coil are reduced, which should lead to savings in chiller, pumps and cooling tower energy. As the temperature drops further, the cooling plant may be able to be turned off completely. In variable air volume systems it may be worth raising the supply air temperature to allow the cooling plant to be turned off to produce energy savings that exceed the increased fan energy consumption.

RISKS

Physical access may prevent retrofit of economy cycle controls.

If the control systems fails, the dampers may be opened at the wrong time which will waste energy instead of saving it. Good maintenance is critical.

PROCESS

Estimate feasibility of retrofitting dampers and controls.

Calculate costs & benefits.

Install dampers and controls.

Commission the system to ensure minimum fresh levels.

Modify maintenance schedules to check correct operation.

COSTS

$5,000 to $10,000 per air handling system. (BCA RIS)

PAYBACK

Medium. Will be quicker for systems that operate longer hours and for buildings with smaller minimum fresh requirements or larger internal loads.

RESOURCES

Khutoryanskiy, L., “Optimising an airside economiser”, Ecolibrium, AIRAH Journal, Vol. 55, No. 4, 2001.

Controls - Heating

HVAC - 09

In Melbourne's temperate climate at many times part of the building will need heating while other parts need cooling. Controlling heating plant to minimise the chance of "heating fighting cooling" is vital to achieving an efficient result.

BENEFITS

Making heating controls responsive to demand will save both heating AND cooling energy with associated cost savings.

RISKS

If these strategies are applied too aggressively, some parts of the building may be under-heated (too cold). Introduce one measure at a time and monitor heating performance. If one area takes longer to warm up, find out why. It may be a lack of supply air or a balancing problem. Solve THIS problem rather abandoning the new control strategy.

OPPORTUNITIES

- Boiler optimization sequencing.
- Outdoor temperature reset of heating hot water temperature.
- Switch off boiler after morning warm-up.
- Reduce zone thermostat heating setpoint.

COSTS

Commission a HVAC engineer to determine feasibility and cost effectiveness.

PAYBACK

Short.

RESOURCES

Australian Greenhouse Office – HVAC Efficiency Opportunities

www.greenhouse.gov.au/lgmodules/wep/hvac/training/training14.html

Controls - Schedules

HVAC - 10

This opportunity is about matching supply of services to the actual, current demand. How long before most occupants arrive is the HVAC system started? Can the plant be started later at some times of the year? Does the plant continue to run on public holidays? If heating and/or cooling is turned off early, but fans continue to run, how long does it take for the building to become uncomfortable?

BENEFITS

For every hour that HVAC operating time is reduced, associated energy consumption will drop by 5 to 10%.

RISKS

If these strategies are applied too aggressively, some parts of the building may be uncomfortable at times. Introduce one measure at a time and monitor performance. If one area becomes uncomfortable before the others, find out why. It may be a lack of supply air or a balancing problem. Solve THIS problem rather abandoning the new control strategy.

OPPORTUNITIES

- Install programmable zone thermostats.
- Lock out simultaneous heating and cooling.
- Reduce zone thermostat heating setpoint, raise cooling setpoint.
- On/off daily, weekly, holiday scheduling.
- Optimum start/stop.
- After hours operation by manual override, occupancy sensor or security.
- Unoccupied zone temp setback or shutoff.

COSTS

Costs are usually low – often these changes will simply require adjustment of existing controls.

PAYBACK

Short

RESOURCES

Price, B., “Maintenance for Energy Efficiency and Ongoing HVAC System Tuning”, Ecolibrium Journal AIRAH April 2007. www.airah.org.au/downloads/2007-04-01.pdf

Controls - VAV

HVAC - 11

Variable Air Volume systems are a popular solution to supplying air conditioning to varying loads that vary in space and time. VAV systems can save fan and reheat energy but need to be tuned carefully to deliver these benefits without compromising comfort.

BENEFITS

Reducing air flow rates saves fan energy consumption. E.g. Reducing air flow to 75% will save 50% of fan energy. Improving control of VAV systems can also alleviate two common problems with VAV systems: cold air dumping (at low flow rates) and lack of air flow to lightly loaded zones.

RISKS

VAV system controls can be complex and it is easy to solve one problem but cause another. E.g. Scheduling colder supply air will save fan energy but may increase chiller energy and cause discomfort. So monitor overall energy performance and survey for comfort problems.

OPPORTUNITIES

- Reduce static pressure setpoint to minimum required to deliver air to remote outlets.
  Monitor which zones are most often demanding cooler air. Increasing air flow to these zone will save cooling energy and reduce cold air dumping.
- Monitor which zones are often operating at minimum air flow. Review minimum air flow settings.
- Fine tune supply air controls to maximise use of economy cycle, maintain adequate air change rates and save fan energy.
- Establish minimum airflow prior to reheating.
- Refine core and perimeter sequences for winter warm-up.
- Introduce unoccupied mode: minimum air (or shutoff) and no reheat.

COSTS

Costs are usually low – often these changes will simply require adjustment of existing controls.

PAYBACK

Short

RESOURCES

Haessig, D., “Variable air volume control for VAV fan terminals”, Ecolibrium Journal AIRAH November 1994.

Muir, I., “Air distribution principles and how they apply to VAV systems”, Ecolibrium Journal AIRAH May 1999.

Smeed, J., “Some Australian VAV design anomalies and solutions”, Ecolibrium Journal AIRAH November 1998.

de Villiers, N.A, “Guide to the Design of an Effective Low Pressure VAV Air Distribution System”, Ecolibrium Journal AIRAH May 2000.

Cooling Towers – Energy

HVAC - 12

Cooling tower fans consume energy but cooling tower performance also impacts on chiller efficiency.

BENEFITS

Improve cooling tower features and controls to save energy with associated cost savings.

RISKS

The overall cooling system efficiency must be considered. In some cases it may be better to run the cooling towers harder to gain chiller energy savings.

OPPORTUNITIES

- Optimize control of multiple towers with multi or variable speed fans
- Reduce condenser water temperature to save chiller energy.
- Use induced draft (axial fan) over forced draft (centrifugal) when possible
- Use two-speed or variable-speed fan instead of water bypass to modulate capacity

Increase Condenser Efficiency

- Water-cooled versus air cooled
- Evaporative-cooled versus air cooled
- Condenser water reset controls

COSTS

Specify more efficient cooling tower to reduce Leaving Water Temperature: $3,000 to $5,000. Based on the increase the size of a medium capacity tower by one size to achieve closer approach to Wet Bulb temperature.

Two-speed or VSD condenser fan motor: $3,000 to $5,000. Based on 7.5kW motor

Evaporative-cooled versus air cooled: $40,000 to $60,000. Extra cost for 1000kW evaporative/air cooled chiller system over and above chiller system with conventional cooling tower.

PAYBACK

Varies

RESOURCES

Green Star Technical Manual – Office Design v2: ENE-02

Archibald, J.; Gavelis, M., “Economies of Selecting Air Cooled Versus Water Cooled Refrigeration Equipment”, Ecolibrium Journal AIRAH February 2002. www.airah.org.au/downloads/2002-03-02.pdf

Cooling Tower – Water

HVAC - 13

Cooling towers can account for up to 30% of a commercial buildings water use.

BENEFITS

Reducing the water use of cooling towers through efficiency measures or replacement can lead to significant water savings.

RISKS

None

OPPORTUNITIES

Reduce the building cooling loads.

Require make-up water to replace evaporation and blow down.

Use cycles of concentration of 12-15 in Melbourne.

Control blow down by monitoring TDS (total dissolved solids) concentration.

Control evaporation through efficient operation of system and reducing load.

Consider use of non-potable water for makeup.

COSTS

Alternatives to cooling towers can cost 20-50% more upfront.

Recycled water systems with suitable treatment can cost in the order of $100-200K.

PAYBACK

Payback periods are short for cooling tower efficiency improvements.

Paybacks on alternatives to cooling towers and recycled water systems can be as low as 2-3 years where the initial water use is high.

RESOURCES

Green Star Technical Manual – Office Design v2: WAT-4

City West WaterMAP™ - www.citywestwater.com.au/business/watermap_program.htm

Pumps

HVAC - 14

Most commercial building have pumps for transferring heat around the building: chilled water pumps, condenser water pumps, heating hot water pumps etc. As they tend to be operated for long periods the associated energy consumption can be substantial.

BENEFITS

Saving in energy consumption and maximum demand with associated cost savings.

RISKS

Low

OPPORTUNITIES

Match pump performance to system flow requirements by machining the pump impellor or fitting a variable speed drive.

Reduce System Flow and/or Pressure Drop by:

- Increasing cooling coil temperature difference,
- Increasing heating coil temperature difference,
- Reduce pump head pressure losses through piping and fittings, control and balancing valves, heating and cooling coils, boiler and chiller units.

COSTS

Pump impellor trimming: $2,000 to $4,000. Remove, trim, replace.

Variable-speed motor drives: $3,000 to $5,000 each, installed.

PAYBACK

Payback will depend on range of loads experienced and hours of operation.

RESOURCES

Ahlgren, R.C.E., “Why Did I Buy Such an Oversized Pump?”, ASHRAE Transactions, Vol. 107, No. 2, 2001.

Internal Fitout

External Views

INT - 01

In office buildings the provision of views to the outside allows building users who typically spend many hours undertaking close work in front of computer screens to refocus on long distance views thereby reducing eyestrain.

BENEFITS

External views also provide a visual connection to the outside, promoting occupant wellbeing and amenity.

Australia's Green Star rewards buildings and tenancies where the majority of the net lettable area is within 8m of vision glazing.

The UK's BREEAM (Building Research Establishment Environmental Assessment Method) rewards buildings where all desks are within 7m of a window.

RISKS

Challenging if the existing office space has limited access to views.

PROCESS

In refurbishments where the external façade glazing is in place, views to the outside can be achieved by carefully designing the internal spaces and partitions. Occupied spaces should be located on the perimeter of the floor plate and utility spaces and infrequently used spaces e.g. meeting rooms should be located on the interior of the floor plate.

All workstations should have a direct line of sight at eye level to the outside through glazing.

COSTS

Negligible if considered early.

PAYBACK

Low

RESOURCES

AS1680.1 – 1990 Interior Lighting – General Principles and Recommendations

CIBSE, "SLL Lighting Guide 10:Daylighting and window design", 1999.

Green Star Technical Manual – Office Design v2: IEQ-8, Office Interiors v1.1: IEQ-7, Office As Built v2: IEQ-8

Indoor Plants

INT - 02

Provide indoor plants to improve the indoor environment.

BENEFITS

Research shows that plants have an ability to reduce indoor air contaminants, such as VOCs, improving the indoor environment quality and thus enhancing occupant health and wellbeing.

In a study conducted by Dr. Virginia Lohr of Washington State University*, employees in offices containing indoor plants were 12% more productive and less stressed than those who worked in plant-free environments.

RISKS

Indoor plants must be nurtured to remain healthy. Neglected (or dead!) plants are more likely to have a negative influence on occupants.

PROCESS

Plants that are suitable for an indoor environment should be selected and incorporated into the office space. Details of their maintenance, watering and cleaning requirements should be incorporated into the building or tenancy's Maintenance Plan to ensure that they remain healthy. Appoint someone to this task in each area or outsource.

COST

Plants can hired and maintained for around $1,500 per year to meet the Green Star requirements for 10 staff.

PAYBACK

Low

RESOURCES

*Lohr, V.I., C.H. Pearson-Mims, and G.K. Goodwin. 1996. Interior plants may improve worker productivity and reduce stress in a windowless environment. J. of Environmental Horticulture 14(2):97-100.

National Interior Plant Association (NIPA): www.nipa.asn.au

Plants at Work: www.plantsatwork.org

Green Star Technical Manual – Office Interiors v1.1: IEQ-15

Internal Finishes & Fittings

INT - 03

Selecting low environmental impact internal finishes and fittings including paints, carpets, partitions, flooring and walls/doors.

BENEFITS

Improved indoor air quality

Reduced energy and water use in the production of materials

RISKS

Material availability may be the limiting factor.

opportunities

Low emissions materials and fixatives.

Recycled materials content.

Renewable materials content.

Recyclable material use.

COSTS

Low VOC Carpet: No additional cost..

Low VOC Paint: No additional cost..

Low emission formaldehyde: No additional cost.

Other certified products often come at a cost premium.

PAYBACK

Staff health and well-being benefits.

RESOURCES

Good Environmental Choice Australia: www.aela.org.au/

Ecospecifier: www.ecospecifier.org/

Green Star Technical Manual – Office Design v2: IEQ-13,14

Green Star Technical Manual – Interior v1: MAT

Volatile Organic Compounds (VOCs)

INT - 04

VOCs are organic chemical compounds found in many building materials and products that have high enough vapour pressures under normal conditions to vaporise, or off-gas, and enter the atmosphere.

Sources of VOCs can include carpets, sealants, new furniture, reconstituted wood products, paint, adhesives, solvents, cleaning products, office equipment and printed material.

Formaldehyde is a widely-used chemical that is considered to be a VOC. Formaldehyde resins and glues are used principally in composite wood products such as particleboard.

Printing and photocopying can produce VOCs, including particulate pollution from toner, ozone and carbon monoxide, all of which are detrimental to indoor air quality and can affect the health of workers.

BENEFITS

Using products with low or zero VOC content will reduce the health risks described below.

RISKS

This increases the indoor air contaminant level and is detrimental to the health of building occupants. Symptoms are consistent with “sick-building syndrome” and could include headaches and irritation to eyes, nose and skin.

PROCESS

In order to promote indoor air quality in refurbishment projects, products and materials that are low in VOCs should be selected.

Ecospecifier, a database of environmentally preferable products, materials, technologies and resources, can assist in the selection process.

All composite wood products selected for structural uses, workstations, chairs, tables, partitions, flooring, ceilings, cupboards, joinery, storage etc. should be low formaldehyde emission and eco-labelled E0 (or E1).

Ideally, printing/photocopying facilities should be located in a separate room to the general occupied office space. This room should have a dedicated exhaust to extract the air contaminants.

Organisations should develop a procurement strategy where environmentally preferable office products, equipment, cleaning products, processes and services are outlined and implemented. The Australian Environmental Labelling Association (AELA) website has a section on green procurement.

The high environmental performance cleaning products selected and cleaning processes developed should be incorporated into the Maintenance Plan.

COST

Low

PAYBACK

Low - Medium

RESOURCES

Good Environmental Choice Australia: www.aela.org.au

Ecospecifier: www.ecospecifier.org

AS1668.2-2002 The Use of Ventilation and Air-conditioning in Buildings –Ventilation Design for Indoor Air Contaminant Control.

Green Star Technical Manual – Office Design v2: IEQ-13, 14 and 16, Office Interiors v1.1: IEQ-11, 12 and 14, Office As Built v2: IEQ-13, 14 and 16.

Ventilation Rates

INT - 05

High levels of Carbon Dioxide (CO2) can indicate inadequate ventilation.

BENEFITS

In buildings that are mixed-mode, naturally ventilated or mechanically ventilated, the increased intake of fresh outside air expedites the dilution of indoor air contaminants (e.g. VOCs, body odours), thus improving the indoor environment and the health of the building's occupants.

According to a study conducted by Wargocki (2000)* for each two-fold increase in ventilation rate, performance improved on average by 1.7%.

According to Olli Seppanen (2002)** the available data for office buildings in moderate or cold climates indicates that occupant health and perceived Indoor Air Quality (IAQ) will usually be improved by avoiding ventilation rates below 9 L/s per occupant and indicates that further improvements in health and perceived IAQ will sometimes result from higher ventilation rates up to 18 L/s per occupant.

For a major refurbishment, assessment of the existing ventilation rates will assist in determining if natural ventilation and/or mechanical plant is able to meet the required ventilation rates to promote a healthier indoor air environment.

Green Star promotes increased ventilation rates for mixed-mode, naturally ventilated or mechanically ventilated buildings by offering credit where they exceed AS1668.2-1991 and/or AS 1668.2-2002 where relevant.

RISKS

Indoor air quality in enclosed office spaces can be significantly decreased by high levels of CO2, affecting the health, wellbeing and productivity of occupants.

PROCESS

During the refurbishment process, an investigation should be undertaken and the building's ventilation rates determined.

For mechanically ventilated buildings, it should be demonstrated that ventilation rates are higher than that required by the relevant Australian Standard: AS 1668.2-1991. This requires a minimum fresh air supply of 10 L/s/person. Usually this results in between 5 and 10% of the air supply being fresh air introduced into the system.

For naturally ventilated buildings, it should be demonstrated that the net lettable area is naturally ventilated in accordance with AS 1668.2-2002.

For mixed mode buildings, it should be demonstrated that the ventilation rates of the mechanical ventilation component exceeds AS 1668.2-1991 and that the relevant net lettable area is naturally ventilated in accordance with AS 1668.2-2002.

If the building's existing mechanical ventilation systems do not currently meet or exceed these requirements they should be adjusted. If the existing plant is unable to meet or exceed these requirements, replacement/upgrade of the plant should be factored into the Assets List.

If the building's natural ventilation component does not meet AS 1668.2-2002, there is little that can be done under the Maintenance Plan. A Level 2 refurbishment would be required.

COSTS

Medium

PAYBACK

RESOURCES

* Wargocki P.; Wyon D.P.; Sundell J.; Clausen G.; Fanger P.O. in “The Effects of Outdoor Air Supply Rate in an Office on Perceived Air Quality, Sick Building Syndrome (SBS) Symptoms and Productivity”, Indoor Air, Volume 10, Number 4, 1 December 2000

** Seppanen O.A, W.J. Fisk, M.J. Mendell in “Ventilation Rates and Health”, ASHRAE Journal August 2002*

AS1668.2-1991 The Use of Mechanical Ventilation and Air-conditioning in Buildings – Mechanical Ventilation for Acceptable Indoor Air Quality. This Australian Standard outlines standards for air movement, humidity, temperature and fresh air requirements in an office building.

AS1668.2-2002 The Use of Ventilation and Air-conditioning in Buildings –Ventilation Design for Indoor Air Contaminant Control. This Australian Standard provides design standards for natural ventilation openings through prescriptive requirements, computer modelling or empirical calculations.

Green Star Technical Manual – Office Design v2: IEQ-1, Office Interiors v1.1: IEQ-1, Office As Built v2: IEQ-1

CO2 Monitoring & Control

INT - 06

High levels of Carbon Dioxide (CO2) can indicate inadequate ventilation. Indoor air quality in enclosed office spaces can be significantly decreased by high levels of CO2, affecting the health, wellbeing and productivity of occupants.

BENEFITS

The installation of sensors that monitor CO2 levels and adjust outside air supply accordingly result in improved indoor air quality and consequently, improved occupant health and productivity.

Energy savings may be obtained by regulating outside air volumes in response to occupancy levels.

RISKS

When the ambient temperature is hot or cold, increasing outside air quantities carries an energy penalty. The controls must be maintained to ensure correct operation.

PROCESS

For mechanically ventilated buildings that recirculate a proportion of air, the refurbishment process should include the installation of one CO2 sensor per return air duct for the net lettable area. The sensor should monitor CO2 levels and adjust outside air intake accordingly.

CO2 sensors are not necessary for buildings that are mechanically ventilated with no air recirculation or for buildings that are naturally ventilated where air flows can be controlled by the occupants

COSTS

CO2 monitoring & control: $700 to $2,000. CO2 monitoring to regulate outside air quantity on single AHU.

PAYBACK

Would need a value on fresh air.

RESOURCES

AS1668.2-2002 The Use of Ventilation and Air-conditioning in Buildings –Ventilation Design for Indoor Air Contaminant Control.

Green Star Technical Manual – Office Design v2: IEQ-3, Office Interiors v1.1: IEQ-2, Office As Built v2: IEQ-3.

Individual Control

INT - 07

Allowing individuals control over their own environment including heating, cooling and ventilation.

BENEFITS

Control over your own environment can lead to higher levels of thermal comfort and increased occupant satisfaction and productivity and a lower incidence of occupant complaint.

Could lead to energy savings where users are absent or are comfortable in a wider range of conditions than conventional office conditioning.

Green Star gives credit to naturally ventilated buildings with operable windows or individual mechanical supply controls.

RISKS

Technology must be coupled with information so that users have full control.

PROCESS

If HVAC, lighting or window systems are being changed during the refurbishment process, consideration should be given to enabling building occupants to individually and directly control their own thermal and visual environment. Spaces should be appropriately zoned to reflect usage patterns and controls for heating, cooling, ventilation and lighting located in close proximity to workers. Controls for daylighting and glare, such as sun shading and blinds, should be easily accessible to building users. HVAC and lighting controls should be clearly labelled. An outline of how these systems operate and their controls should be located in a tenant manual accessible to all staff.

COST

Costs are minimal if cellular offices with operable windows are used. If control is to be supplied mechanically, allow 10-20% above a standard system.

PAYBACK

Medium

RESOURCES

Green Star Technical Manual – Office Design v2: IEQ-10, Office Interiors v1.1: IEQ-8, Office As Built v2: IEQ-10.

ASHRAE Handbook of Fundamentals 2001

Developing an Adaptive Model of Thermal Comfort and Preference – final report on ASHRAE RP884

Lighting

Lighting - Efficiency

LI - 01

Various methods exist to improve the light received on the working plane per unit electricity consumed. These include; high efficiency light reflectors, replacing or removing cloudy diffusers, reducing general light levels but providing task lighting, reducing lighting in overlit areas; ensuring light fittingsare clean and replacing old tubes with blackened ends.

BENEFITS

Lighting can be designed to reduce energy consumed while providing lighting levels adequate for the tasks being lit

GreenStar awards 4 points for best practice and 1 point for 3.0 W/m^2 per 100 lux

RISKS

Ensure that light levels are not compromised.

Ensure that new arrangement does not cause visual discomfort due to glare or reflections.

OPPORTUNITIES

- Determine what the current lighting density is in relation to tasks being performed in that area.
- Light power densities for 95% of NLA – Best practice = 1.5 W/m^2 per 100 lux .
- Choose light colours to improve light reflection within space.
- More efficient lamps: T5 16mm tubes, T8 25mm tubes, compact fluorescent or LED downlights.
- High frequency ballasts.
- Fit new reflectors.
- Replace/remove old diffuser: new prismatic or egg-crate diffuser.
- Install lighting control units.

COSTS

T5 light fittings: $20-25 per fitting (10% over T8)

High frequency ballasts: No extra cost.

Dimmable Ballasts: 30-40% over standard fittings

PAYBACK

Payback is within three years.

RESOURCES

www1.sedo.energy.wa.gov.au/uploads/comm_light_26.pdf

Green Star Technical Manual – Office Design v2: ENE 05 and ENE 06

Lighting - High Frequency Ballasts

LI - 02

Fluorescent lamps fitted with high frequency electronic ballasts reduce eye strain and save energy.

BENEFITS

Standard low frequency magnetic ballasts operate the fluorescent lamp at the mains frequency of 50 Hz, switching the light on and off 100 times per second. This flicker can be detected by the eye, causing headaches and eyestrain.

High frequency electronic ballasts operate at above 20,000Hz with the resulting flicker rate at over 40,000Hz. This is beyond the perception of the eye, leading to improved visual comfort in the workplace.

High frequency ballasts prolong lamp life and are more energy efficient than their low frequency predecessors, resulting in lower energy bills.

RISKS

None.

PROCESS

During the maintenance process, it should be determined whether the existing fluorescent lighting has low or high frequency ballasts.

If the lamps have low frequency ballasts, these magnetic ballasts could be upgraded to electronic ballasts.

As a minimum, all of the occupied spaces within the net lettable area should contain fluorescent lighting with high frequency ballasts.

COSTS

High frequency ballasts: $80 to $95 per fitting. Based on two tube fitting. No extra cost.

PAYBACK

Medium

RESOURCES

Ballasts for linear fluorescent lamps manufactured in or imported into Australia must comply with Minimum Energy Performance (MEPS) requirements which are set out in AS/NZS 4783.2-2002.

The Australian Greenhouse Office:

www.energyrating.gov.au/ballasts1.html

International Electrotechnical Commission (IEC):

www.iec.ch/

Green Star Technical Manual – Office Design v2: IEQ-6

Lighting – Controls

LI - 03

Various lighting controls such as push button timers, motion detectors and infra red sensors are available to switch lights off when an area is unoccupied..

Other controls switch off or dim lights when ambient light is available.

BENEFITS

Many Australian office buildings are over-lit. Building occupants can suffer from visual discomfort if lighting illuminance levels are too high or too low for the tasks that they are undertaking.

In addition to promoting occupant health and wellbeing, the ability to maintain optimal electric lighting levels in offices will contribute to energy savings.

RISKS

Many lighting control systems have failed because of human factors. E.g. Daylight controls that switch lights off have been bypassed due to frequent switching under scattered cloud. Poorly located infra-red occupancy sensors switch on office lights whenever anyone passes the open office door even though the office is empty.

For safety reasons, some spaces will need a small light left on so that an occupant is not left in complete darkness, should the lights turn off unintentionally.

PROCESS

During the refurbishment process, activity-specific electric lighting levels should be determined and set for each space. If not suitable, the existing light fittings could be fitted with controls to limit their illuminance or the luminaires upgraded to provide the appropriate lighting level.

AS1680.2.2 – 1994 “Interior Lighting – Office and Screen-based Tasks” specifies recommended values for illuminance for a range of office-based tasks.

Determine suitable controls for switching lights off when the space is unoccupied.

Trial new controls in a small area and refine before wider implementation.

Select new internal blinds for solar control.

COSTS

Occupancy sensors: $1 to $4/m^2 of GFA. Assumes sensors in all open spaces and private offices.

Lighting Controls: $2 to $4/m^2 of GFA. Price for typical lighting control systems in offices building (eg: additional switching and dimming)

PAYBACK

Medium

RESOURCES

AS1680.1 – 1990 Interior Lighting – General Principles and Recommendations

AS1680.2.2 – 1994 Interior Lighting – Office and Screen-based Tasks

CIBSE, “SLL Lighting Guide 10:Daylighting and window design”, 1999.

Green Star Technical Manual – Office Design v2: IEQ-5 and IEQ 7, Office Interiors v1.1: IEQ-4 and IEQ-6, Office As Built v2: IEQ-7

Lighting – Glare

LI - 04

Whilst the provision of natural daylighting can result in improved occupant health, productivity and reduced energy consumption, it's important to ensure that glare does not become an issue.

BENEFITS

Glare from direct sunlight and exterior reflecting surfaces on desks, computer screens etc. has a detrimental effect on the visual comfort of occupants.

RISKS

None

PROCESS

For refurbishments, glare can be minimised by the addition of appropriately designed fixed external shading and/or through the addition of adjustable internal blinds/screens that are able to be directly controlled (automatically or manually) by building occupants.

Reflective Film on windows gives a constant reduction in glare but also visible light transmittance.

COSTS

Architectural shading and overhangs: $300 to $1,500 m^2 of sun shade.

Internal blinds: up to $50/$m^2$

PAYBACK

High

RESOURCES

AS1680.1 – 1990 Interior Lighting – General Principles and Recommendations

Nick Baker and Koen Steemers, "Daylighting Design of Buildings", James and James, 2002.

CIBSE, "SLL Lighting Guide 10: Daylighting and window design", 1999.Green Star Technical Manual –Office Design v2: IEQ-4, Office Interiors v1.1: IEQ-3, Office As Built v2: IEQ-4:

Lighting – Zoning

LI - 05

Lighting design that offers flexibility for light switching to be zoned can assist in reducing energy consumption.

Best practice is where all individual spaces have individual switches and in open plan offices, individual zones to be <100m^2 for 95% NLA and switches are clearly labelled and accessible. A narrow (4 to 6m) zone along each perimeter wall may allow lights to be switched off when ambient light levels are adequate.

BENEFITS

Energy savings are achieved by better matching lighting provision to the actual requirements. E.g. if one person works late, only a small area needs to be lit instead of the whole floor.

RISKS

If workgroups or space functions change the lighting zoning scheme may not suit the new requirements.

PROCESS

Determine current switching layout, location & labelling of switches.

Determine work groupings, space usage pattern, schedules etc. Consider cleaning, security, after hours.

COSTS

Lighting : $1 to $2/m^2 of GFA. Extra circuits to reduce lighting energy in unoccupied areas. Assume halve size of current zones.

PAYBACK

High

RESOURCES

Green Star Technical Manual –Office Design v2: ENE-6

Lighting – Optimise Daylight

LI - 06

Improve levels of daylight available within the building. Provide an automatic dimming system to perimeter lighting systems.

BENEFITS

Natural daylighting promotes occupant health and wellbeing and has a positive influence on worker productivity.

Whilst there have not been any comprehensive studies undertaken linking natural daylighting to productivity in office buildings, there have been a number of studies conducted in educational facilities. In 1999, the Herschong Malone Group* conducted a study into the relationship between daylighting and student performance in three school districts in the US. Students in classrooms with the most daylighting were found to have between 7% and 26% higher scores than those with the least, leading the authors to conclude that there is a valid and predictable effect of daylighting on student performance.

In addition, the provision of natural daylighting reduces reliance on artificial lighting, thereby reducing energy consumption and energy bills.

RISKS

The provision of natural daylighting must be carefully balanced with any heat loss, heat gain or glare problems that may result.

Glazing areas and sun shading devices must be carefully determined and designed for each facade to allow winter sun (to facilitate passive heating) and exclude summer sun (to avoid overheating and excessive use of the air-conditioning system).

Care must be taken to avoid glare due to direct sunlight and reflectance from glazing and outside surfaces.

PROCESS

If required, natural daylighting levels can be increased in refurbishment projects by increasing the area of glazing or replacing the glazing with glazing that has higher light transmittance.

As a general rule, occupied spaces of office buildings should have an average daylight factor of 2.5%.

COSTS

Dimming controls: $6,000 to $9,000. Price for lighting control for 4 dimmed sets of lights and 12 non dimmed sets of lights.

PAYBACK

High

RESOURCES

AS1680.1 – 1990 Interior Lighting – General Principles and Recommendations

Nick Baker and Koen Steemers, “Daylighting Design of Buildings”, James and James, 2002.

CIBSE, “SLL Lighting Guide 10:Daylighting and window design”, 1999.Green Star Technical Manual –Office Design v2: IEQ-4, Office Interiors v1.1: IEQ-3, Office As Built v2: IEQ-4:

*Hechong Mahone Group “Daylight in schools: An investigation into the relationship between daylighting and human performance”, 1999

Green Star Technical Manual – Office Design v2: IEQ -4

Office Equipment

Office Equipment – Purchase

OE - 01

The purchase of office equipment, either a new item or the replacement of an existing one, provides an ideal opportunity to improve energy efficiency.

BENEFITS

Ongoing savings in energy. Improving the efficiency of equipment located in an air-conditioned space will also save cooling energy.

RISKS

From time to time it may be prudent to review new technology becoming available in each of the key energy end-uses.

PROCESS

Ensure that energy consumption is considered when equipment is being purchased. Annual energy consumption & cost can be estimated. A multiplier of 1.3 should be applied to include the impact of cooling energy to remove the heat gain from equipment. For photocopiers this analysis should extend to all consumables: paper, cartridges etc. The cost of operating equipment can quickly overtake its purchase price.

Develop strategy to replace inefficient equipment and include in Asset Plan.

The Asset Plan should identify equipment that is nearing the end of its economic life and highlight opportunities for energy-efficient replacement.

COSTS

Energy efficient appliances may cost more than standard equipment.

PAYBACK

Varies.

RESOURCES

Australian Energy Star www.energystar.gov.au has information about how to purchase and operate energy efficient office equipment.

Green Office Guide: A guide to help you buy and use environmentally friendly office equipment - www.energyrating.gov.au/library/pubs/greenofficeguide.pdf

Office Equipment –Power Management

OE - 02

Most computers and printers in use today have ENERGY STAR energy saving features built in, but few are “enabled” to use these features.

If left inactive, ENERGY STAR enabled computers enter a low-power mode and use 15 watts or less. New chip technologies make power management features more reliable, dependable, and user-friendly than even just a few years ago.

BENEFITS

ENERGY STAR reduces the amount of energy consumed by a product by either automatically switching it into a 'sleep' mode when it's not being used and/or reducing the amount power used when in 'standby' mode.

RISKS

None.

PROCESS

Enabling energy saving simply involves changing some settings within the “Control Panel” and can be done manually or automatically on a single PC or across a company via its network.

COSTS

Energy Star appliances do not cost more than standard equipment.

PAYBACK

Less than one year.

RESOURCES

www.energystar.gov.au

www.sustainability.vic.gov.au

Green Star Technical Manual – Office Design v2:

Green Office Guide: A guide to help you buy and use environmentally friendly office equipment
www.energyrating.gov.au/library/pubs/greenofficeguide.pdf

EZ Wizard is a free program that will enable power management on your monitor in seconds:
www.energystar.gov/index.cfm?c=power_mgt.pr_pm_wizard

Renewable Energy

Renewable Energy – GreenPower™

RE - 01

GreenPower™ is certified renewable energy sourced from the sun, the wind, water and waste.

BENEFITS

An average Australian home that has subscribed to 100% accredited GreenPower™ (including off peak) would save approximately seven tonnes of greenhouse pollution every year which is equivalent to removing almost two cars from the road.

Advocacy for renewable energy options.

RISKS

Ensure that the product you are buying is certified GreenPower.

OPPORTUNITIES

- Eight energy retailers in Victoria offer GreenPower™
- Alternatively, accredited organisations that allow you to stay with your current provider and purchase GreenPower credits are available.
- The electricity providers will then supply an equivalent amount of certified Green Power to the grid.

COSTS

Energy retailers are offering 100% GreenPower™ at a 2-5.5c/kWh premium (12-37% extra).

PAYBACK

None.

RESOURCES

www.greenpower.gov.au

Green Electricity Watch – Compares and ranks GreenPower™ products available to small through to large businesses - www.greenelectricitywatch.org.au

Renewable Energy – Active

RE - 02

Active renewable energy systems include: wind, solar and micro-hydro.

BENEFITS

Reduced reliance on grid electricity.

Reduced energy bills.

Energy and greenhouse gas savings.

RISKS

Renewable energy supplies are may require back-up from more traditional sources.

OPPORTUNITIES

Solar: Photovoltaics, Solar walls, Solar thermal, Solar Pumps

Wind: Micro turbines

Hydro: Micro-hydro

Government rebates and carbon credits are available.

COSTS

Photovoltaics - $10,000 - $14,000 per kW for roof mounted cells

Wind turbines - $5,000 - $10,000 per kW

Micro-hydro - $2,000 per kW

PAYBACK

High

RESOURCES

Green Star Technical Manual – Office Design v2: Ene-1

www.greenhouse.gov.au/renewable/

Waste

Rubbish & Recycling

WST - 01

Much of the waste generated by offices can be easily recycled.
Paper makes up to 80% of waste.

BENEFITS

The provision of dedicated storage space for the separation, storage and collection of recyclable resources will encourage recycling. Recyclable resources include: paper, glass, metallic, and organic materials.

The space needs to be accessible to both staff and collection agencies.

Recycling companies can provide receptacles suitable for their purposes.

E.g. – co-mingled recycling bins

RISKS

Lack of education and training can reduce the efficacy of recycling programs.

PROCESS

Space needs to be provided in a convenient space to allow for separation of recyclables and storage of waste.

Area requirements.

Provision of well labelled and colour-coded bins.

Educational material.

COSTS

The most significant cost will be to change to a waste collection agency that collects all recyclable products.

PAYBACK

Not applicable.

RESOURCES

Green Star Technical Manual – Office Design v2: Mat-1 Recycling Waste Storage

EcoRecycle Victoria www.ecorecycle.vic.gov.au

www.visy.com.au

Transport

Transport – Public Transport

TR - 01

In 2002 transport accounted for 16.5% (19.3 Mt CO2-e) of Victoria's greenhouse gas emissions. Cars accounted for 68% of these emissions, goods vehicles 30% and buses 2% (1999 figures).

After buildings, transport is the second fastest growing emissions sector.

On average in Australia and New Zealand, the total private transport CO2 emissions per capita in 1995 was 2107kg per person,1060% more than the total public transport CO2 emissions per capita of 199kg per person.

BENEFITS

Saves staff money and stress from driving to work during peak hour. Reduces greenhouse gas emissions associated with travel to and from work.

RISKS

Two thirds of Melburnians are not serviced well by public transport, especially those living in newer outer-suburban areas.1

Strong peak period use can be a deterrent – could encourage staggered starting times at work.

Lack of information can be a deterrent to use.

Ticket prices.

PROCESS

Office transport tickets for travel within city during office hours – purchase bulk tickets.

Signage – timetables on office noticeboards; map showing main routes that provide access to office.

Education.

Establish interest free loans to buy annual public transport ticket.

COSTS

Minimal cost to businesses and money is saved in comparison to taxi or own travel.

PAYBACK

Non-definable

RESOURCES

Green Star Technical Manual – Office Design v2: Tra-4 Commuting Public Transport

TravelSmart – Information on alternatives to car transport - www.travelsmart.vic.gov.au

Transport - Bicycles

TR - 02

Increased use of bicycles contributes to reduced road congestion, reduced greenhouse gas emissions and provides health and economic benefits to cyclists.

BENEFITS

To reduce GHG emissions associated with travel to and from the building.

RISKS

Ensure the bicycle facilities are adequately spaced and are safe for users.

PROCESS

Provide space for lockers, showers, change rooms, and a secure lock-up area.

GreenStar recommendations are to provide bicycle parking for 10% of building staff based on one person per 15m^2 NLA, with 1 accessible shower for every 10 bicycle spaces, and changing facilities with a secure locker for every bicycle space. Further to this, bicycle parking for visitors is recommended at one space per 750m^2 NLA.

Office bicycle for bicycle trips to nearby locations during office hours.

COSTS

Support for Bicycle Use: $2 to $6 per m^2 of gross floor area to Green Star requirements.

PAYBACK

Not applicable.

RESOURCES

Bicycle Victoria www.bv.com.au/

Green Star Technical Manual – Office Design v2: Tra-3 Cyclist Facilities

Transport – Fleet Vehicles

TR - 03

According to Greenfleet, an average car produces 4.3 tonnes of CO2 per year.

BENEFITS

To reduce GHG emissions associated with travel to and from the building.

A recent exercise undertaken by the City of Manningham found that hybrid vehicles emit 50% less GHG than larger 6 cylinder vehicles running on LPG or petrol.

RISKS

None.

PROCESS

This can be achieved through calculating the GHG emissions generated by the business and offsetting through programs such as Greenfleet.

COSTS

One carbon offset company has quoted a figure of planting 17 native trees on your behalf to neutralise your car's greenhouse emissions for one year for $40.

PAYBACK

Manningham City Council discovered a small cost premium of $2,000 per year.

RESOURCES

Environmental Indicators for Melbourne:
www.aius.org.au/indicators/casestudy.cfm?ThemeID=13&CaseStudyID=70&CaseStudies=true

www.greenfleet.com.au/supporters/fleet.asp

www.greenvehicleguide.gov.au

Water

Water – Demand Management

WA - 01

Water use in commercial buildings is 10 – 20% of total water demand in urban supply. Demand management can go along way towards reducing drinking water consumption to the Victorian Government White Paper target of 15% by 2010 per capita.

BENEFITS

Water efficient taps not only reduce the amount of both hot and cold water use, they also reduce the energy used to heat water.

Typical tap flow rate is 10-12 litres/minute which can be reduced to 2.5 L/minute.

Standard urinal uses 6 litres per flush - Water efficient urinal uses 2.8 L per flush - Waterless urinal.

Water sensitive urinal (saves 1.5 ML/a cf. water efficient urinal based on 4 flushes per day).

Non-efficient shower heads have flow rate of approximately 11 L/minute. This can be reduced to 9L/minute.

RISKS

Sensor taps require energy to operate

OPPORTUNITIES

Install flow control valve to all fittings to achieve an equivalent saving to new fittings at low cost.

Educate staff on water saving practises.

Upgrade tap-ware and sanitary fittings to highest star rating.

Use sensors and timers in high use areas.

Water sensitive urinals are rapidly entering the market – see the water ratings website for new products.

COSTS

Wash hand basin: $285 to $550 each. Set in vanity (Vanity excluded) Fixture only, no allowance for reticulation.

Tapware: $220 to $350 each.

WC Suite: $360 to $602 each. Standard dual flush system floor mounted; fixture only no allowance for reticulation pipework.

Sensor taps: $1,260 to $1,380 each. Tap only; no reticulation; excludes TMV.

Waterless Urinals: $1,350 to $1,540. Fixture only.

PAYBACK

Flow control valves typically have a payback of 1-2 years. Replacement of fittings and cisterns have a higher payback of around 5 years.

RESOURCES

www.waterrating.gov.au

Victorian Government White Paper ‘Securing Our Water Future together” (2004)

Green Star Technical Manual – Office Design v2: Wat-1

Sub-Metering – Water

WA - 02

Leaks and water wastage can be responsible for up to a quarter of water use in commercial buildings. Sub-metering can facilitate water monitoring.

BENEFITS

Allows the collection of data on major water uses within a building for easy historical analysis.

Enables early detection of leaks and water wastage which can also cause building damage.

Makes it easy to identify water saving solutions and quantify the benefits.

RISKS

Sub-metering results should be communicated to users.

PROCESS

The following water uses should be metered: bathrooms; cooling towers; irrigation; recycled water systems; and hot water services.

Link to a Building Management System to identify leaks.

Develop a monitoring regime to collect and analyse metered data.

Provide feedback to tenants, staff who control or maintain the monitored equipment.

COSTS

Sub-metering: $450 to $700 per item. Extra price for BMCS but excludes water meter.

PAYBACK

Often one to two years.

RESOURCES

Green Star Technical Manual – Office Design v2, WAT-02

www.savewater.com.au

Water - Monitoring

WA - 03

A monitoring program can be used to identify potable water consumption trends. It can be used to identify where potable water savings can be made to improve building performance.

BENEFITS

Assists in determining exactly where and when water is used on the site.

This strategy can be useful in identifying leaks and water use after hours.

RISKS

The more check meters in place, the more useful the data.

PROCESS

The simplest type of monitoring program involves reading the mains water meter manually or through the use of a data logger regularly over a period of time. More detailed monitoring of water use can be achieved in several ways: internally through the use of a Building Management System; remotely through a link to a data centre; or through the use of individual check meters in potential problem areas.

Ideally, large water uses in the building are identified and then metered to check their use for a period of at least a month. Readings are taken daily at close of business and prior to opening to assist in identifying leaks and after hours use. The measured data is then reviewed to identify leaks and high usage area. The data can be checked automatically if using a computerised system which can set off an alarm or cut water iif the use is unusually high

COSTS

Check meters cost in the range of $200 - $2,000 per unit. On-going costs are reduced when an automated monitoring system is installed as part of the building works.

PAYBACK

Up to 30% reduction in water use with reported paybacks of 2-10 years.

RESOURCES

www.citywestwater.com.au

www.sewl.com.au

www.yvw.com.au

Green Star Technical Manual – Office Design v2: WAT-2

Water – Conservation Plan

WA - 04

A Water Conservation Plan will help set priorities and targets to reduce water use.

BENEFITS

Having a Water Conservation Plan clearly communicates water reduction goals to both staff and clients.

It also allows the future allocation of funds to actions that may not be immediately accessible.

RISKS

Having a plan does not necessarily lead to savings. The plan must be supported with funding and staff commitment.

PROCESS

To form a Water Conservation Plan the following steps should be followed:

- Review current water use including any water audit results
- Involve and educate staff
- Set targets
- Identify actions
- Estimate costs, water savings, payback, responsibility, date for completion for each action
- Prioritise actions and form plan.

COSTS

Water conservation plans can be done in-house or through a professional. Consultants may charge up to $30,000 to complete a detailed plan.

PAYBACK

No direct water savings can be attributed to the development of a Water Conservation Plan.

RESOURCES

Chanan V, White S, Howe C, Jha M, Sustainable Water management in commercial Office Buildings, Institute for Sustainable Futures, Innovations in Water: Ozwater Convention 7 Exhibition, Perth, April 2003.

www.citywestwater.com.au

www.sewl.com.au

www.yvw.com.au

www.savewater.com.au

Water – Recycling

WA - 05

Standard practice in Australia has been to return water to the sewer after one use. Water recycling offers opportunities to reuse this water for non-potable uses within the building.

BENEFITS

Re-use of water for cleaning, cooling tower make-up, fire system testing and toilet flushing can reduce water use by 50%.

Reduced load on the sewerage system.

RISKS

Treatment systems must be well maintained to ensure that there are no risks to human health.

The type of reuse allowed is determined by the quality of the treated water and must be approved by the Environmental Protection Authority.

PROCESS

Grey water collected from showers, hand basins, and kitchens can be treated and reused for cleaning, cooling tower make-up, toilet flushing, fire-protection or sub-surface irrigation.

Blackwater collected from toilets can be treated and returned to class A quality and reused for toilet-flushing, irrigation and fire protection.

Water used in fire tests can also be stored and reused.

Ensure water recycling systems are carbon neutral by making energy efficiency a priority.

COSTS

Smaller treatment systems for irrigation and toilet flushing will cost up to $10,000 however the cost of a medium scale commercial treatment system is in the order of $600,000 to $1,200,000 for Blackwater and $300,000 to $600,000 for Grey water. On-going maintenance costs should also be considered. Fire-system holding tanks are in the order of $10-20,000.

PAYBACK

Depends on the size and type of the system but generally high for full treatment.

RESOURCES

Environment Protection Authority www.epa.vic.gov.au

Green Star Technical Manual – Office Design v2: Wat-1, Emi-6

City West WaterMAP™ - www.citywestwater.com.au/business/watermap_program.htm

Online Resources

City of Melbourne

Information on the City of Melbourne's environmental initiatives and programmes.
www.melbourne.vic.gov.au/environment

Australian Institute of Refrigeration Air Conditioning and Heating

Website contains index to AIRAH Journal (now called Ecolibrium) and Industry Directory.
www.airah.org.au

Your Building

Online information source about Australian sustainable commercial buildings
www.yourbuilding.org

Sustainability Victoria

www.sustainability.vic.gov.au

City West Water

Water Conservation Solutions Handbook
www.citywestwater.com.au/business/docs/Handbook_final.pdf

Department of the Environment and Heritage

ESD Design Guide for Australian Government Buildings - Edition 3, May 2007
www.environment.gov.au/settlements/publications/government/esd-design/index.html

Water Efficiency Guide: Office and Public Buildings, October 2006.
www.environment.gov.au/settlements/publications/government/water-efficiency-guide.html

Green Building Council of Australia

www.gbcaus.org

Green Star Technical Manual – Office Design v2 (See here for information on how to purchase)

The Dollars And Sense Of Green Buildings 2006 - Building the Business Case for Green Commercial Buildings in Australia www.gbcaus.org/gbca.asp?sectionid=15&docid=1002

The Property Council of Australia

www.propertyoz.com.au

PCA published "Energy Guidelines" in 2001. 83pp on design, operation and management.

Savewater!®

Information on how to save water. www.savewater.com.au

Standards Australia

www.standards.org.au

U.S. Office of Energy Efficiency and Renewable Energy

High Performance Buildings www.eere.energy.gov/buildings/highperformance/

Office Energy Checklist www.eere.energy.gov/femp/services/energy_aware_oec.html

References

ERDC, “Study into the Energy Efficient Renovation of Commercial Buildings”, Lincolne Scott Australia P/L, 1996.

Investa, “Green Lease Guide for commercial office tenants”, Investa Properties Limited, 2006. 40pp contains many checklists of ESD opportunities.

N.S.W. Department of Conservation & Environment, “Sustainable Property Guide” to be published in 2007; gives an excellent approach to improving sustainability in the operating phase.

Appendix A: List of Opportunities by ESD Category

General			
Maintenance Plan	GEN - 01	AB	7
Long Term Maintenance Contracts	GEN - 02	AB	9
Green Lease	GEN - 05	A	14
Gross Lease	GEN - 06	A	15
Building Users Guide	GEN - 08	A	18
Green Building Rating (GBCA)	GEN - 19	ACD	33
Energy			
Re-Commissioning - Tuning	GEN - 03	A	10
Building Management Control System	GEN - 04	B	12
Energy Audit	GEN - 11	A	21
Energy Target	GEN - 12	A	23
Australian Building Greenhouse Rating	GEN - 17	ACD	30
Reduce DHW Demand	DHW - 01	BD	36
Reduce DHW Distribution Losses	DHW - 02	BD	37
Efficient DHW Generation	DHW - 03	BD	38
Reduce Peak Electrical Demand	EL - 01	BD	39
Efficient Motors And Drives	EL - 02	BD	40
Sub-Metering – Energy	EL - 03	BD	41
Reduce Heat Losses	EN - 01	D	43
Reduce Heat Gain	EN - 02	D	44
Reduce Infiltration	EN - 03	BD	46
Air Handling System Upgrade	HVAC - 01	D	49
Boilers – Replace / Upgrade	HVAC - 02	D	51
Boiler System Efficiency	HVAC - 03	BD	52
Chiller Efficiency	HVAC - 04	BD	53
Chiller – Replace / Upgrade	HVAC - 05	D	54
Controls – Air Handling	HVAC - 06	BD	55
Controls – Cooling	HVAC - 07	BD	56
Controls – Economy Cycle	HVAC - 08	BD	57
Controls – Heating	HVAC - 09	BD	58
Controls – Schedules	HVAC - 10	BD	59
Controls – VAV	HVAC - 11	BD	60
Cooling Towers – Energy	HVAC - 12	BD	62
Pumps	HVAC - 14	BD	64
Lighting – Efficiency	LI - 01	BCD	74
Lighting – High Frequency Ballasts	LI - 02	CD	76
Lighting – Controls	LI - 03	BCD	78
Lighting – Zoning	LI - 05	CD	81
Lighting – Optimise Daylight	LI - 06	D	82
Office Equipment – Purchase	OE - 01	ABCD	84
Office Equipment – Power Management	OE - 02	AB	85
Renewable Energy – Passive	RE - 01	A	86
Renewable Energy – Active	RE - 02	D	87

Do you have a question for the Melbourne City Council?
Call and speak to us.

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9280 0717	廣東話
9280 0718	Ελληνικά
9280 0719	Bahasa Indonesian
9280 0720	Italiano
9280 0721	普通話
9280 0722	Somali
9280 0723	Español
9280 0724	Türkçe
9280 0725	Việt Ngữ
9280 0726	All other languages
9280 0727	English

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