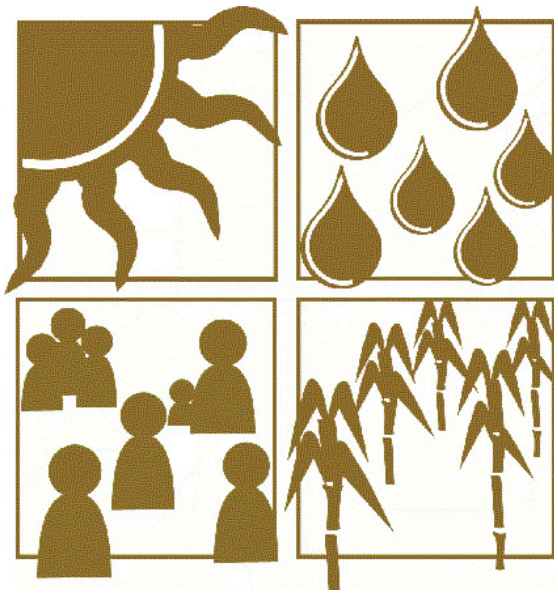

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ECOLOGICALLY SUSTAINABLE DESIGN IN OFFICE FITOUT

Abstract

This Guideline provides a basis for planning and designing ecologically sustainable initiatives in the fitout of office buildings. The main intent of the document is to effectively consider:

- Conservation of resources and heritage; and
- Emissions abatement for health protection.

It contains strategy options, critical elements, checklists, a self-assessment framework and several supporting case studies to illustrate key performance benchmarks.

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1 INTRODUCTION

Definitions

Objectives of this Guideline

1 INTRODUCTION

In the Australian built environment, there is depletion of natural reserves of freshwater, clean air and, naturally productive land, as well as pollution of urban air to an extent that it can be detrimental to the health of both human communities and natural ecosystems [1]. On a global scale, the widespread habitat deterioration and destruction, climate change and depletion of scarce natural resources causes community concern [2]. The United Nations has responded by undertaking the following:

- Kyoto Protocol on Climate Change (1997);
- Rio Convention on Biological Diversity (1992), and
- Montreal Protocol on Ozone Depletion (1987).

The need to incorporate Ecologically Sustainable Development (ESD) principles into human settlements was translated into the Australian context by the National Strategy for ESD, 1992 [3]. In addition, the National Greenhouse Response Strategy endorsed by the Council of Australian Governments in 1996, was a further national commitment to ESD [4, 5].

It is essential for the health and economy of the community to provide direction for future integration of effort and to improve ecologically sustainable trade and employment prospects. The Built Environment Protocol launched in Brisbane in 1997, established directions for ESD in line with state, national and international agreements [Appendix A].

Definitions

Ecologically Sustainable Development

ESD is defined as: "using, conserving, and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased" [3]. This covers a range of issues and activities which are typically grouped into two broad categories:

- Conservation of water, air, land and community resources; and
- Abatement of emissions affecting water, air and land quality.

The keys to ensuring a sustainable and healthy relationship between buildings, their occupants and the wider environment are to improve communication, understanding, and our knowledge base along with technical development over the asset life cycle. This includes phases of planning, design, purchasing, construction, management-in-use and disposal [1].

Fitout

Fitout is defined as: "the process of designing and building a physical workplace environment within, or in association with, a building's structure, envelope and services. The fitout process is dynamic and continuous and includes consideration of the impact of the fitout in-use as well as the fitout's disposal" [6].

Objectives of this Guideline

The purpose of this document is to provide planners, designers, contractors and end-users of office accommodation with a practical guide to address ESD considerations within the scope of fitout activity. This guideline applies to both fitout and refurbishment of existing office accommodation and new office buildings. The aims are to significantly enhance the performance of building occupants and reduce local and global environmental impacts, particularly in the operations phase. The intended outcome of this document is to provide guidance for:

- Working towards a healthier and ecologically sustainable office building fitout;
- Continuing improvement to reduce risks associated with known hazards; and
- Engaging with industry to improve sustainable trade and employment prospects [1].

2 METHODOLOGY

FRAMEWORK AND APPROACH

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Framework of Considerations for Reducing Environmental Impacts

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ESD AND STRATEGIC ASSET MANAGEMENT

Strategic Asset Management

Australian and International Practice

EVALUATING ESD IN OFFICE FITOUT

The Rating System

2 METHODOLOGY

FRAMEWORK AND APPROACH

Environmentally responsible management is based on objective assessment, planning and design of all significant considerations [7-14]. This guideline provides a framework for reducing environmental impacts as outlined below.

Information Sources

Throughout these guidelines and their supporting checklists particular issues of concern are itemised in various categories. This was considered useful to focus effort, to provide for an easier appraisal and to facilitate effective responses. Each item is considered separately in:

- Guidelines for conserving resources and minimising emissions, and
- Checklists for tracking effort at each phase of work.

The information used to produce the guideline originated from various sources including:

- Reviews of current environment guidelines and collation of data from selected case studies.
- The experiences of private practitioners implementing environmental guidelines in their work.
- A review of government environment initiatives for best practice.
- Input from a review panel representing various industry interests.

Framework of Considerations for Reducing Environmental Impacts

For any community, key outcomes include a sustainable source of supply and healthy levels of emissions. Because all supply comes from air, land and water sources and all waste emissions go to air, land and water sinks, supply and emissions are the basic elements to consider [10-14]. By definition, any framework for ESD has to reflect the quantity and quality of air, land and water on which communities rely [8-19]. A framework developed to consider the two key outcomes (Section A - Conserving Resources and Section B - Reducing Emissions) affected by these sources and sinks, is shown in Table 1.

Table 1. Framework of Considerations for Reducing Impacts Associated with Fitouts

Section A. Conserving Resources of			
1a. Community	**2a. Energy**	**3a. Materials / Land**	**4a. Water**
Natural heritage	Passive solar design	Materials durability	Efficiency in use
Cultural heritage	Efficiency in use	Waste avoidance	Waste avoidance
Built heritage	Waste avoidance	Reliance on renewable	Waste management
Access and safety	Preserve non-renewable	Preserve non-renewable	
Section B. Reducing Emissions to			
1b. Air Indoors	**2b. Air Outdoors**	**3b. Materials / Land**	**4b. Water**
Volatile organics	Ozone depleting gases	Construction waste	Effluent reduction
Ventilation	Greenhouse gases	Recycled materials	Waste treatment
Indoor air quality	Airborne particulates	Toxic waste avoidance	Drinking water quality
User control			

Rules of the Road for ESD

The Natural Step Foundation's road rules for sustainable development are considered substantial enough to be both useful and scientifically valid [20] and are the most fundamental issues to consider. To become sustainable, organisations need to act to reduce their reliance on:

1. Finite resource use;
2. Pollution creating activities;
3. Consumption of natural reserves; and
4. Ineffective and inequitable operations.

OUTLINE AND CONTENTS

This guideline provides a framework of considerations for reducing environmental impacts. It forms the basis for planning, designing and rating ecologically sustainable initiatives in the fitout of office buildings.

The guideline contains information on strategy options, critical elements, self-assessment checklists and several supporting case studies to illustrate key performance benchmarks. To facilitate tracking, checklists for each phase of the fitout project process are provided. These checklists may also be used to rate ESD initiatives outlined herein.

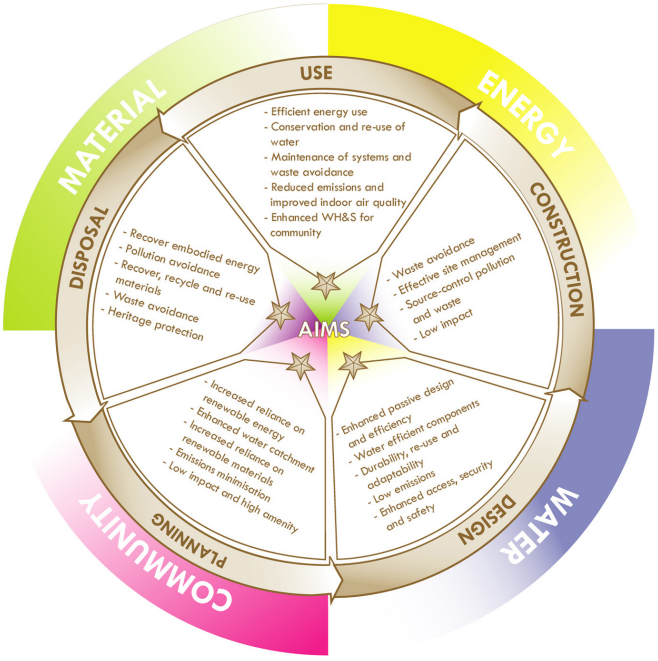
ESD AND STRATEGIC ASSET MANAGEMENT

For Ecologically Sustainable Strategic Asset Management (ESSAM), buildings, agencies and suppliers can be objectively assessed against resource and emission criteria in each phase of the asset life cycle.

Strategic Asset Management

An ESSAM Framework and rating system can reflect the performance of buildings, agencies and suppliers in achieving ESD compliance. In addition, to enhance service delivery and cost effectiveness, key aims in each phase of the asset life cycle are outlined in Figure 1.

Figure 1. Key Goals over the Asset Life Cycle



The following approaches are considered fundamental in ecologically sustainable practice:

- Passive design plus daylighting with intelligent operating systems;
- Reduced reliance on non-renewable materials, fuel and energy sources;
- Increased energy efficiency with enhanced natural or mechanical ventilation;
- Procurement of materials/systems with re-use and recycling capabilities; and
- Water conserving fittings and devices.

Key areas for implementation of such practice in a building include:

- Envelope; layout and design (both internal and external);
- Materials and finishes (both insulation and off gassing implications);
- Water saving fixtures and fittings such as flow control in toilets and taps;
- Energy efficient appliances, lighting and fixtures; and
- Enhanced user control of indoor environments.

AUSTRALIAN AND INTERNATIONAL PRACTICE

Best and standard practice varies according to the building type, climate, region, occupancy rates and services delivered. Nevertheless, it is important to consider and plan for improved outcomes based on relevant prior, current and future performance benchmarks. Effective planning, design and reporting in any building fitout is reliant on project specific data, from a base case, to show improved outcomes for the following:

- Energy use per square metre of floor space (considering service delivery and occupancy rate);
- Water use per square metre of floor space (considering service delivery and occupancy rate);
- Waste avoidance and reduction in fitout construction and demolition; and
- Recycling rate per tonne of material used, re-used and disposed.

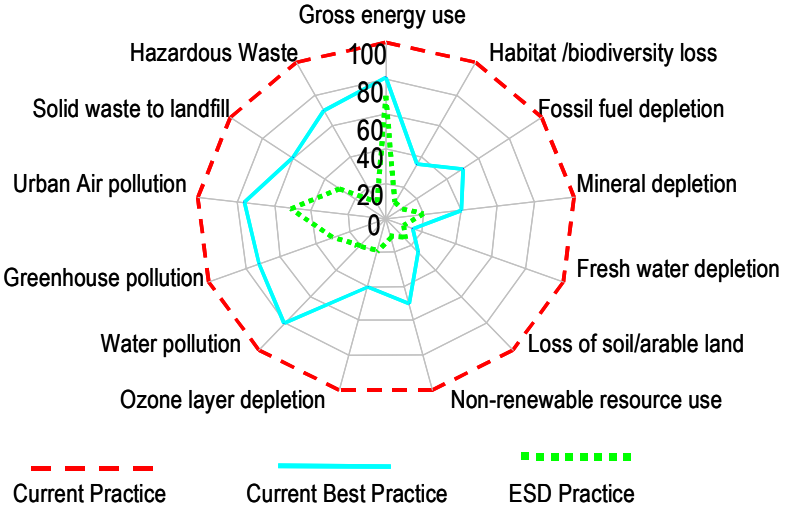
Indicative benchmarks for office energy use (MJ/square metre per annum) are shown below:

- Standard Practice; 640 (NSW Public Works and Services 1993) [21]; and
- Best Practice; 300 (Lease Plan Company, Amsterdam, The Netherlands) [21].

The following ecological footprint model compares current, best and ESD practice. Current practice is shown as the outer circle, compared with contemporary best practice shown in continuous lines. The inner dotted line depicts improvement required for ecologically sustainable performance.

A business-as-usual approach can be compared with improved performance. Outcomes can be reported in the categories shown in the following Figure 2 or those identified in the guideline.

Figure 2. Building Fitout Ecological Footprint.

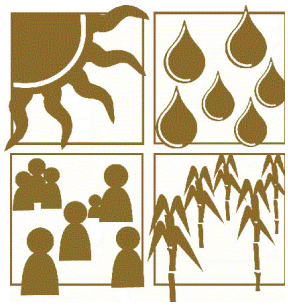


EVALUATING ESD IN OFFICE FITOUT

The guideline addresses the following four categories and icons developed for use throughout this document:

2. Energy

4. Water



1. Community

3. Materials/Land

Checklists have been developed to implement strategies across these four categories throughout all fitout phases.

The guideline and the checklists share a common numerical rating system to support decision making.

The Rating System

A combined numerical and 'star' rating system was developed to recognise and differentiate the particular approaches required of the many agencies and suppliers in fitout.

The rating system has been included in this ESD guideline. Checklists to support decision-making provide a tool for both the client and project teams to summarise and analyse progress, and discern the level of performance required from the start of project planning.

The rating system can also be used to:

- Prioritise responses;
- Focus the efforts of professionals in any areas of concern;
- Compare, verify and analyse strengths and weaknesses; and
- Plan for an overall improved outcome.

An aggregated numerical score can be compared against five performance levels to establish an overall star rating for a project.

The star rating may also be used to differentiate approaches taken by organisations and suppliers involved in fitout projects. Using the rating system has the potential to drive improvements in overall performance, return on investment and sustainable technology.

Each item in a category has a numerical value from 1-5 depending on its ESD contribution. Higher scoring items indicate higher ESD importance. To achieve a star rating, users circle each item and tally the numbers for a total score of between 1 and 300 as shown in the following table 2.

Table 2. Star Rating Table

Rating	Score	Logo	Description
✯	0 - 99	Eco-Starter	Encouragement award for getting started.
✯✯	100 - 149	Eco-Improver	Improvement award for applied effort.
✯✯✯	150 - 199	Eco-On-track	Fast track award for improved outcomes.
✯✯✯✯	200 - 249	Eco-Leader	Leadership award for significant achievement.
✯✯✯✯✯	>250	Eco-Best-Practice	Best practice award for ESD Outcomes.

All items identified in the guideline should be considered when undertaking a fitout project.

A total of 475 points is available if all items in the guideline are implemented on a project.

The additional 175 points above the 300 (available in the star rating system) provide a 'float' to avoid penalising projects where the scope of works may be limited (e.g. for a minor fitout). Alternatively, where a scope of work for a fitout project is limited, a pro rata approach may also be taken.

The scores are derived from the total of the ratings. Each rating represents numbers of points scored for each item implemented. Maximum points are allocated for addressing key ESD issues while minor points can be gained for showing consideration of certain issues without necessarily implementing the fullest response.

Together, the guideline, checklists and rating system form the basis for audits and accreditation of agencies, suppliers, contractors, projects and project Teams as well as for auditing an actual fitout.

Altogether, this set of tools will facilitate:

- Benchmarking performance, improved project timing and communication;
- Professional group initiatives;
- ESD solutions;
- Conserving community, energy, materials, water and resources;
- Reducing emissions to air, land and water; and
- Product specification for ESD fitout design.

During project initiation, the project team should consider which rating to aim for. The greatest opportunities for improved ESD outcomes in fitout relate to the community and indoor air.

3 FITOUT GUIDELINE

GUIDELINE CATEGORIES

GUIDELINE FOR COMMUNITY

Part A. Conservation of Community Resources and Heritage

Part B. Reduced Emissions to Air Indoors/Occupants

GUIDELINE FOR ENERGY

Part A. Energy Conservation

Part B. Avoided Induced Climate Change

GUIDELINE FOR MATERIALS

Part A. Conservation of Material Resources

Part B. Solid and Toxic Waste Avoidance

GUIDELINE FOR WATER

Part A. Water Conservation

Part B. Avoidance of Emissions to Water

3 FITOUT GUIDELINES

GUIDELINE CATEGORIES

The guideline relates to community, energy, materials and water and each has two principal outcomes, Resource Conservation and Emissions Abatement. Refer to the following Table 4 for an overview of these categories.

Table 4. Guideline Categories

Community		
Outcome: Conservation of Community Resources		
Habitat and Biodiversity	Access and Safety	Built and Cultural Heritage
Endangered species Cleaner production Natural fabrics Pest control and cleaning Plantings/participation	Hazardous materials Minimise building hazards Security and health issues Equitable access Accurate fitout information	Information and education Maximise flexibility Rubbish/removal procedures
Outcome: Reduced Emission to Air Indoors/Occupants		
Airborne Particles	Hazardous Emissions	Enhanced Ventilation
Central vacuum cleaning Protect occupants	Chemical storage/records Cleaning practice VOCs, toxic fume, EMFs	Natural ventilation Ambient air intake

Energy		
Outcome: Energy Conservation		
Passive Use of Daylight	Passive Design	Energy efficiency
Sources and control Thermal issues	Renewable energy sources	Efficient use Waste avoidance
Outcome: Reducing Emissions to Air (Outdoors)		
Ozone Depletion	Induced Climate Change	
Emissions reduction Energy and materials	Energy initiatives Materials and water	

Materials/Land		
Outcome: Conservation of Materials		
Renewable Sources	Recycled Materials	Distribution/Durability
Sustainable sources Resource depletion	Recycled/and recyclable	Transport energy/durability/ Waste
Outcome: Avoidance of Waste Materials		
Solid Waste To Land	Toxic Waste To Land	
Recycling and re-use Waste avoidance	Records of toxic materials Toxic materials	

Water		
Outcome: Water Conservation		
Efficient Use	Waste Avoidance	
Fittings and appliances	Source options Pressure/maintenance	
Outcome: Avoidance of Emissions to Water		
Effluent Reduction	Waste Management	Water Quality
Effluent control	Grey/black water	Healthy water

GUIDELINE FOR COMMUNITY

Part A. **Conservation of Community Resources and Heritage**

Objective: **To protect natural heritage, habitat and biodiversity**

Strategy: ***Enhance reliance on sustainable practice***

Recommendation	Implementation	Rating
Protect endangered species Appendix B	Specify plantation timbers with origins recorded.	5
	Specify plantation source in timber frame partitions/furniture.	4
	Specify preference for certified plantation timbers.	3
	Record reference to appropriate species selection listing.	5
	Avoid use of tropical hardwood unless it is recycled.	5
Promote cleaner production principles Appendix C	Specify alternative materials to vinyl/lowest polyvinylchloride (PVC) content in:	5
	• Floor coverings;	5
	• Cabling;	2
	• Furniture components;	3
	• Conduit, ducting; and	3
	• Venetian blinds.	5
	Minimise use of PVC wherever practical.	5
	Give preference to bio plastics over synthetic plastics.	
Select natural fabrics	Specify organic fabrics with:	
	• High flame resistance; and	1
	• Low toxicity qualities e.g. wool, silk.	1
	Minimise use of fire retardants containing VOCs.	1
Consider pest management	Specify/check effective sealing of all:	
	• Joints; and	3
	• Service penetrations.	3
	Design out crevices/spaces for pest/vermin nesting.	1
	Include a pest management protocol in Handover Manual.	1
	Report on existing spraying and improved pest control to client.	1
Promote responsible cleaning	Obtain supplier specification for organic cleaning approach.	1
	Promote applicators' best organic cleaning practice to client.	1
	Include manufacturer recommendations/direction for use of natural cleaning products in Handover Manual.	1
Provide indoor plantings	Locate plants <3m from light of 400-to 850 nm wavelengths.	1
	Ensure trays protect carpet/joinery from moisture ingress.	1
	Design appropriate access for watering/replacing plants.	1
	Specify plants free of pests, disease or toxic chemicals.	1
	Record plantings maintenance program in Handover Manual.	1
	Specify plants that filter toxins from indoor air.	1
	Recommend plants to 'high churn' work environments.	1
	Select plants that contribute to the local habitat.	1
Encourage participation	Facilitate surveys of occupant needs/responses.	1
	Report survey results to the occupants' representative.	1
	Facilitate response to post occupancy review of fitout.	1

Objective: **To ensure community access and safety**

Strategy: ***Provide safe and accessible facilities***

Recommendation	Implementation	Rating
Audit hazardous materials within base building	Test for lead if surfaces were painted pre-1980.	1
	Determine if any relic materials contain asbestos e.g. in:	
	• Vinyl tiles;	1
	• Fibro sheeting;	1
	• Air-conditioning heater banks; and	1
	• Fibrous insulation.	1
	Check for PCBs in old capacitors/fluorescent fittings.	1
	Report on existing pest management practice to client.	1
	Manage risks identified in Hazardous Materials Audit.	1
Design to minimise building hazards	Specify non-slip flooring.	1
	To prevent accidental scalding:	
	• Specify upper limit of hot water temperature; and	1
	• Obtain a compliance report.	1
	To avoid injury:	
	• Specify no sharp edges to furniture/fittings; and	1
	• Specify no sharp edges to metal/joinery items.	1
	At floor level changes specify:	
	• Contrasting colours to stairs;	1
	• Tactile indicators as appropriate; and	1
	• Transitional thresholds.	1
Identify security and health issues	Throughout the fitout process liaise with client or OH&S Officer to:	
	• Assess potential health and safety risks; and	3
	• Develop a risk management plan.	3
	Review tenancy occupation and co-ordinate with construction.	1
	Review tenancy operations and building/occupant security.	1
	Plan to pre-wire for proposed security systems.	1
	Ensure doors contain vision panels where appropriate.	1
	Separate food storage areas and rubbish bins in kitchens.	1
	Specify secure separation of construction and occupied areas.	1
	Request information about special needs of occupants.	1
Provide equitable access	Review, ascertain and ensure compliance to AS 1482 part 1.	3
	Review and ascertain the need to comply with AS 1482 part 2.	3
	Provide for special needs of parents of infants.	5
	Provide for safe visitor access.	1
	Provide carer space to meet occasional family demands.	1
Enhance operations with accurate fitout information	To ensure fire safety:	
	• Review existing egress plans;	1
	• Check new documentation; and	1
	• Plan distribution and viewing of emergency procedures.	1
	Collate material safety data from all material suppliers.	1
	Provide a Handover Manual to include ESD information.	1
	Recommend post occupancy studies in Handover Manual.	1
	Register occupant contributions during design process.	1
	Log client and occupant input on ESD issues.	1
	Provide fitout records to support effective operations.	1

Objective: **To protect built and cultural heritage**

Strategy: ***Maximise understanding, flexibility and recycling***

Recommendation	Implementation	Rating
Inform and educate on ESD issues	Canvas client input for and promote ESD fitout objectives.	2
	Promote the ESD approach and justify selections.	3
	Report improved outcomes/lessons learned to clients/occupants.	5
	Contribute to tenant education via ESD report cards.	1
	Encourage and recognise occupant input.	1
	Format Handover Manual for ready reference.	1
Maximise design flexibility and understanding of churn factors	Promote, recommend and specify:	
	• Modular furniture;	3
	• Modular partition systems; and	3
	• Freestanding furniture.	3
	Specify demountable partition systems.	1
	Adopt standard material sizes in design solutions.	1
	Provide soft rather than hard wiring systems.	1
	Provide options for reuse e.g. design for disassembly.	1
	Design for portability/permanence depending on change history.	1
	To avoid discomfort in sensitive occupants/high churn areas recommend spectral reflectors in fluorescent lamps.	1
	Plan for future change based on organisational history.	1
	Design for future flexibility of potential space use in Master Plan.	1
	Establish fitout record system for future retrieval and re-use.	1
Ascertain rubbish/removal procedures	Plan mobile bin storage in accessible spaces.	1
	Determine and provide for recycling options to best handle all:	
	• Paper;	1
	• Plastics;	1
	• Glass; and	1
	• Metals.	1

Part B. **Reduced Emissions to Air Indoors/Occupants**

Objective: **To optimise conditions for occupant health protection**

Strategy: ***Avoidance of airborne particles***

Recommendation	Implementation	Rating
A central vacuum cleaning system	Investigate viability and operational requirements of central vs. current cleaning arrangements.	1
Protect occupants from construction impacts	Tape and seal doorways to occupied areas.	1
	Provide filters to all air-conditioning intakes and exhausts.	1
	Avoid sanding of plasterboard on site.	1
	To minimise on site cutting/sanding specify partition systems.	1
	Thoroughly clean all surfaces on handover.	1
	Specify high efficiency (H.E.P.A) filters in all vacuum cleaning.	1
	Vacuum clean ceiling spaces, ductwork/ceiling tile surfaces.	1
	Provide negative air pressure zones to minimise dust transfer.	1
	Use outside air intake/outlet in A/C supply to/from construction areas.	1
	Liaise with consultant and contractor.	1

Strategy: ***Avoidance of hazardous emissions including volatile organics***

Recommendation	Implementation	Rating
Identify chemical storage areas	Avoid storage/shared ventilation paths of chemicals and food.	1
	Provide adequate ventilation to cleaner's stores/cupboards.	1
Record material compositions	Obtain, review and provide records of material safety data sheets for all materials and cleaning products.	5
Identify fitout-cleaning practice	For all products, collect and provide records of manufacturer's recommendations for low impact cleaning agents.	5
Minimise VOCs in material used Appendix F & G	Review Material Safety data sheets and specify avoidance of:	
	• Benzene compounds;	1
	• Formaldehyde compounds;	1
	• Toluene compounds; plus all	1
	• Synthetic and natural aromatic organic solvents.	1
Minimise sources of toxic fume in case of fire	Avoid CFC and polyurethane foams to furniture.	1
	Prior to specification of all furniture:	
	• Obtain data sheets on padding; and	1
	• Select lowest level and preferably CFC free foams.	1
	Where practical, avoid use of PVC coated or based:	
	• Fabrics;	1
	• Electrical cable; and	1
	• Trims near potential ignition/heat sources e.g. downlights.	1
Consider Electro Magnetic Fields (EMF's)	To ensure compliance, measure EMF fields near:	
	• Air-conditioning plant;	1
	• Electrical risers; and	1
	• All adjacent sub-boards.	1
	Avoid placing staff directly behind any unshielded computers.	1
	Ensure fluorescent task lights are >30cm from occupants.	1
	Specify compact fluorescent task lights where appropriate.	1

Strategy: ***Enhanced ventilation***

Recommendation	Implementation	Rating
Optimise airflow	Identify air-intakes, registers and exhausts.	1
	Avoid placing occupant work areas directly under vent drafts.	1
Optimise natural ventilation	Establish ventilation flow rates for various occupancy rates.	1
	Seek a compliance report from commissioning personnel.	1
Provide quality fresh air	Note the air-conditioning system's capacity for fresh/recirculated air.	1
	Propose purge air cycle during fitout construction.	1
	Identify opportunities for increasing fresh air volumes.	1
	Liaise with consultants and/or maintenance A/C personnel.	1
Increase reliance on ambient air intake	Investigate use of 100% outside air at certain times/periods.	1
	Seek consultant's advice on viability for this under the circumstances.	1
	Plan increased reliance on outside air at certain times/periods.	1
	Recommend reliance on outside ambient air whenever practical.	1

GUIDELINE FOR ENERGY

Part A. **Energy Conservation**

Objective: **To minimise non-renewable energy consumption**

Strategy: ***Maximising reliance on passive use of daylight in design***

Recommendation	Implementation	Rating
Maximise daylight sources	Design/maintain space near windows to optimise daylight penetration.	5
	To maximise daylight but reflect UV or IR penetration install:	
	• Light wells or light shelves;	3
	• Laser cut panels or alternative glazing systems; and	3
	• High-level reflectors/diffusers.	5
Consider daylight control	To reduce glare at source:	
	• Specify glazing films;	1
	• Check reflectivity of surfaces near windows;	1
	• Control reflectance levels on computers/VDUs.	1
	Plan intelligent lighting system to control lights on daylight.	5
	Plan separate switching of all lighting around windows.	4
Understand thermal issues	To ensure occupant thermal comfort:	
	• Identify the effects of windows and orientation with respect to regional locations;	2
	• Establish thermal loadings of each;	1
	• Liaise with consultants to establish heat/air flows before locating workstations near windows;	1
	• Propose external shading for excessive heat loads; and	1
	• Consider application of lighting and thermal simulation tools.	1
Maximise passive design opportunities	To maximise daylight penetration always position open working space within 7m of windows.	3
	Locate offices near building core and open areas near windows.	1
	Locate meeting rooms internally if black out is required.	2
	Exploit windows for maximising daylight to occupant areas.	3

Strategy: ***Waste avoidance in operation***

Recommendation	Implementation	Rating
Waste avoidance	Establish power:	
	• Density efficiency; and	1
	• Targets for artificial lighting.	1
	Conduct energy audit and establish energy targets.	5
	Apply appropriate building energy rating system.	1
	Research/propose most efficient cost effective energy tariffs.	5
	Specify initialising of equipment power-saver-mode programs.	1
	Install surge detectors to avoid accidental damage/waste.	1
	Plan to run air-conditioning systems on ventilation mode during appropriate ambient conditions.	1
	Ensure air-conditioning thermostats suit aspect/occupants.	1

Strategy: ***Increased reliance on renewable energy sources***

Recommendation	Implementation	Rating
Enhance reliance on renewable energy sources	Promote consideration of renewable energy options.	1
	Research energy source options for green power schemes.	1
	Recommend cost effective renewable energy options and inform clients/tenants about green-power scheme options.	1
	Specify solar hot water systems where appropriate.	1
	Consider/promote interactive grid-tied solar power solutions.	1

Strategy: ***Maximising reliance on energy efficiency for operations phase***

Recommendation	Implementation	Rating
Enhance reliance on efficient use of energy	Specify low energy lights throughout.	1
	Always propose fluorescent fittings rather than incandescent.	1
	Consider/recommend intelligent lighting control systems.	1
	Consult energy star rating system when selecting appliances.	1
	Recommend and promote selection of 5-star appliances.	1
	Specify high frequency electronic ballasts.	1
	If appropriate, select liquid crystal display computer screens.	1
	Label light switches and identify areas of control/function.	1
	Provide motion detectors to switches in low occupancy areas.	1
	Minimise artificial lighting levels to corridors and lobbies.	1
	Provide high efficiency: • Fluorescent tri-phosphor tubes; and • Silver tint reflectors.	 1 1
	Consider replacing twin tubes with single high efficiency tubes.	1
	Specify low voltage lighting with dimmers.	3
	Plan light zones to reflect occupant use/proximity to daylight.	1
	Check that opening windows and partition systems do not clash.	2
	Recommend natural ventilation options where appropriate.	2

Part B: **Avoided Induced Climate Change**

Objective: **To reduce greenhouse gas emissions**

Strategy: ***Assess and demonstrate greenhouse gas avoided in conserving energy***

Recommendation	Implementation	Rating
Engage a consultant to assess reduced greenhouse gases from energy initiatives	Audit, calculate and report on greenhouse gas emissions avoided from: • Increased reliance on renewable energy sources; • Enhanced passive design and daylighting; and • Efficient energy use and waste avoidance.	 1 1 1

Strategy: ***Show greenhouse gas saved in conserving materials and water***

Recommendation	Implementation	Rating
Engage a consultant to assess reduced greenhouse gases from materials and water initiatives	Audit, calculate and report on greenhouse gas emissions avoided from: • Increased reliance on renewable materials; • Increased materials recycled content and recyclability; • Efficient materials distribution; • Increased use of long life materials; • Increased reliance on site catchment; and • Water efficient use and waste avoidance.	 1 1 1 1 1 1

Objective: **To reduce ozone depleting gas emissions**

Strategy ***Report on ozone depleting gas avoided in emissions abatement***

Recommendation	Implementation	Rating
Engage a consultant to assess reduced ozone depleting gases from emissions reduction initiatives	Audit, calculate and report on reduced ozone depleting gas emissions from avoiding: • Volatile Organic and Reactive Organic compounds; • CFC free refrigerants; and • SF6 testing of ventilation.	 1 1 1

Strategy: ***Show ozone depleting gases avoided from energy initiatives***

Recommendation	Implementation	Rating
Engage consultant to assess reduced ozone depleting gases from energy initiatives	Audit, calculate and report on ozone depleting gas emissions avoided from: • Increased reliance on renewable energy sources; • Enhanced passive design and daylighting; and • Efficient energy use and waste avoidance.	 1 1 1

Strategy: ***Show ozone depletion avoided via materials/water conservation***

Recommendation	Implementation	Rating
Engage a consultant to assess reduced ozone depleting gases from materials initiatives	Audit, calculate and report on ozone depleting gas emissions avoided from: • Increased materials-recycled content; • Increased reliance on renewable materials; • Efficient materials distribution; • Increased reliance on site catchment; and • Water efficient use and waste avoidance.	 1 1 1 1 1

GUIDELINE FOR MATERIALS

Part A. **Conservation of Material Resources**

Objective: **To conserve natural capital**

Strategy ***Increased reliance on renewable resources***

Recommendation	Implementation	Rating
Increase reliance on sustainable material sources/avoid depleting finite resources Appendix B & E	Promote/specify coir, wool, sisal, jute and linoleum product.	5
	Specify timber from plantation/managed forests only.	5
	Promote/specify wool, cotton, silk, hemp and cane fabric and materials.	5
	Avoid/minimise synthetic composite material where practical.	5
	Minimise reliance on petrochemical derivatives.	5
	Consider timber rather than metal studs for partition framing.	1

Strategy: ***Consideration of recycled materials and recyclability***

Recommendation	Implementation	Rating
Increase reliance on recycled/and recyclable materials	Consider recycled tyre-floor matting where appropriate.	1
	Wherever possible:	
	• Recycle all glass;	1
	• Use recycled glass;	1
	• Re-use all doors;	1
	• Recycle all steel studs;	1
	• Recycle all Plasterboard; and	1
	• Use recycled plastic for signage.	1
	Specify increased recycled content.	1
	Recycle all metal shopfront partition/window components.	5
	Specify material be sorted at demolition and prior to despatch.	5
	Select/design furniture for re-use/recycling and deconstruction.	5
	Select/design building components for recycling/deconstruction.	5
	To promote re-use specify physical fixings not adhesives.	5
	Select only carpet manufacturers who recycle their carpet.	5
	Avoid specifying vending machines reliant on disposable cups.	1

Strategy: ***More efficient materials distribution***

Recommendation	Implementation	Rating
Reduce transport energy	Always specify procurement of increased local content.	1
	Specify/select bulk materials from nearest local source.	1
	Research transportation/embodied energy content of imported product lines and select lower embodied energy supply.	1
	Record manufacturing location of specified items.	1
Avoid restricted delivery on site	Measure lifts to ascertain access for long/sheet materials.	1
	Identify and negotiate any restrictions to site delivery.	1
	Schedule to minimise delay of delivery to site.	1
	Schedule supply to avoid overestimates of material quantities.	1

Strategy: ***Durable components and materials waste avoidance***

Recommendation	Implementation	Rating
Increase durability in system	Maximise use of carpet tiles to allow easy replacement.	1
	Specify wear/life expectations for proposed application.	1
	Specify pull/push plates if required on painted surfaces.	1
	Design guardrails in high delivery/use corridors/corners.	1
	Design appropriate wet weather areas for ingress/egress.	1
Research base building services Refer Appendix D	Identify expected life of mechanical plant/fittings.	1
	Note mechanical services/maintenance contracts.	1
	Ascertain viability of refurbishment versus replacement.	1
	Promote performance contracting/efficient use.	1
Waste management	Devise a best practice waste management plan.	1
	Plan space for waste bins during demolition.	1
	Enhance access for ease of maintenance of all services.	1
	Specify standardised modular furniture.	1
	Avoid fixed furniture.	1
	Use demountable partitions.	1
	Design cupboards for re-use and relocation.	1
	Minimise place-specific custom design joinery.	1
	Specify off site cutting of all materials.	1
	Research to reduce packaging and specify recyclability.	1
	Specify soft wiring and flexible data systems.	1

Part B. **Solid and Toxic Waste Avoidance**

Objective: **To avoid solid or toxic waste to land**

Strategy: ***Ensure components can be recycled and reused***

Recommendation	Implementation	Rating
Design for recycling and re-use	Provide spaces in layout for recycling bins.	1
	Allow for easy access for waste removal for recycling.	1
	Nominate/specify demolished materials to be sorted/recycled.	5
	Design to incorporate recycled doors, glass and joinery.	1
Promote waste avoidance	Promote and educate about waste avoidance and recycling.	1
	Identify recycling options to client in Handover Manual.	1
	Promote re-use of existing furniture and fittings.	1
	Specify use of demountable and re-usable partitions.	1

Strategy: ***Ensure components will not contribute to landfill waste or toxic waste***

Recommendation	Implementation	Rating
Identify and record toxic items	Record locations of old smoke detectors.	1
	Identify PCB capacitors in fluorescent lighting.	1
	Remove lead paint according to approved procedures.	1
	Obtain safety information on removal of suspicious materials.	5
	Recommend asbestos audits.	1
	Specify correct removal of asbestos in:	
	• Vinyl tiles;	1
	• Air conditioning heater banks;	1
	• Fibro sheeting;	1
	• Ceiling components; and	1
	• Insulation.	1
Design to eliminate or minimise toxic materials	Specify low mercury tri phosphor light tubes.	1
	Check all product material safety data sheets.	3
	Review manufacturer recommended safety procedures on all building material/products.	1

GUIDELINE FOR WATER

Part A. **Water Conservation**

Objective: **To conserve water resources and promote efficient water usage**

Strategy: ***Efficient use***

Recommendation	Implementation	Rating
Use efficient plumbing fittings and appliances	Specify water saver showerheads (max flow rate 9.5 litres/min).	1
	Specify aerators to kitchen/laundry/basin waterspouts.	1
	Specify flick mixer rather than individual taps.	2
	Promote water-regulating valves to tenancy main supply.	1
	Specify/select low-water-use appliances, check specifications of consumption and compare options.	1
	Specify efficient, instantaneous hot water rather than storage systems.	1
	Specify ceramic discs to plumbing fittings.	1
	Replace toilet cisterns to include dual flush system.	1

Strategy: ***Waste Avoidance***

Recommendation	Implementation	Rating
Consider source options	Collect fresh/rainwater where practical and permitted.	1
	Avoid reliance on bottled water supply.	1
Regulate water pressure	Check all outlets for water splash.	1
	Specify appropriate fixings to prevent water hammer.	1
Design for maintenance	Ensure all fittings and pipe runs are accessible for maintenance.	1
	Identify any leaking taps and cisterns for immediate rectification.	1

Part B. **Avoidance of Emissions to Water**

Objective: **To reduce effluent and protect water quality**

Strategy: ***Effluent reduction***

Recommendation	Implementation	Rating
Control effluent of construction	Recommend 'cover-sleeve' process to avoid daily paint washout.	5
	Specify that final paint washouts occur away from site.	1
	Prevent liquid/percolated waste entering the drainage system.	1

Strategy: ***Waste Management***

Recommendation	Implementation	Rating
Reuse of grey water	Consider treating or recycling grey water by installing a diversion valve and drainage to a collection tank for re-use.	1
	Develop environmental management plan for water discharge.	1
Reduce black water	Consider composting-toilets where permitted and practical.	1
	Provide grates and strainers to all kitchen sinks.	1
	Monitor insecticide sprays.	1
	Avoid solvent cleaning in sinks.	1

Strategy: ***Ensure water quality***

Recommendation	Implementation	Rating
Promote healthy water quality	Discourage use of bottled water unless strictly maintained.	1
	Check water storage tanks/pipes for decay, fungal growth, etc.	1
	Consider need for inbuilt water purification/sterilisation system.	1

4 BENCHMARKING CASE STUDIES

SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY NSW

ADELAIDE MAIL AND PARCEL CENTRE, SOUTH AUSTRALIA

DANDENONG POLICE AND COURT COMPLEX, VICTORIA

NIAGARA MOHAWK POWER CO, USA

SKANDIA ASSURANCE, STOCKHOLM, SWEDEN

4 BENCHMARKING CASE STUDIES

Case Studies for further reference are described in Table 5 and the following pages:

Table 5. Best Practice Case Studies

Australian Best Practice	International Best Practice
Sustainable Energy Development Authority (SEDA) Office, Sydney Adelaide Mail and Parcel Centre, South Australia Dandenong Police and Court Complex, Victoria	Skandia Assurance, Sweden Niagara Mohawk Power Corp, USA

SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY, NSW

The following case study has been extracted directly from SEDA documentation.

SEDA is a market-oriented agency that seeks to commercialise the exciting myriad of cost-effective clean-energy technologies now struggling to obtain better market share. To prove what can be done, the Sydney city office was redesigned to showcase the best in energy efficient technologies and the use of building materials that have a minimal environmental impact (www.seda.nsw.gov.au/inbus_tools_body.asp). This includes Australia's first rooftop solar power station on a high-rise office building that has been installed. Together, all the features of the SEDA office amount to ecologically sustainable development in action and the total cost per square metre was less than a typical office fitout. SEDA's office features include:

- A highly cost-effective lighting upgrade designed to cut lighting energy consumption by 38%;
- Lights that automatically turn off when natural light is sufficient;
- Sensors that turn off lights when rooms are vacant;
- Australia's first commercial installation of next-generation slimline fluorescent lighting; and
- A current controller on the office lighting.

There was widespread use of low environmental impact materials including:

- Plant-based paints that emit no volatile organic compounds that can be harmful to human health;
- Vegetable dyed coir carpeting;
- Hemp fabrics for upholstery and work station screens;
- Plantation timber desks;
- Chairs built to last that incorporate recycled plastic and aluminium;
- Low emission fibreboards for cupboards and shelving;
- Steel rather than aluminium;
- Salvaged Blackbutt timber milled into flooring; and
- Linoleum (naturally derived from pine resin) for counter-tops.

High-efficiency appliances included:

- Australia's most energy efficient bar fridge;
- Australia's most energy and water-efficient dishwasher; and
- An electric kettle that cuts energy use by 60 per cent compared with a boiling water unit.

ADELAIDE MAIL AND PARCEL CENTRE, SOUTH AUSTRALIA

(Project Contact Kevin Newport, Australia Post, phone 03 9204 7249):

Completed 1993, a lighting upgrade in association with general refurbishment to existing 1970's building used by Australia Post.:

- New lighting system with time of day and daylight linked and occupancy detection switching controls. Switching was further linked to a BMS.
- Due to better efficiency, number of luminaires was reduced by 30% and total number of tubes was reduced by 50%.
- The estimated annual saving 1.38 million kWh or 27% of the electricity used the year before the upgrade.
- Lower energy consumption by the new lighting system has reduced air-conditioning needs in summer and the building management system has allowed more efficient staging of the refrigerant system, reducing running costs. Winter heating demand has increased slightly.
- The combined energy saving and tariff changes reduced annual energy costs by $235,000 (44%) to $300,000. This represents a payback period of two years and an internal rate of return on investment of 42%.

DANDENONG POLICE AND COURT COMPLEX, VICTORIA

In January 1993, Fletcher Construction Australia selected two similar Melbourne construction sites for trials of a waste reduction program (Wettenhall and Vickery 1995). The pilot project compared the construction of two suburban police and court complexes, at Dandenong and Frankston, in Melbourne, which were similar in design. While the Frankston crew used normal waste disposal methods, the Fletcher team at Dandenong tested a series of waste minimisation measures developed for the pilot project. The main points to note from the case study are:

- Products containing recycled materials were sought for incorporation into the project.
- Recycled, bricks and paper were purchased for use in the project.
- On site recycling of the metals, roof tiles, bricks and structural steel of the existing police, court and community buildings are estimated to have saved $10,500 on waste removal.
- Waste materials were separated on site into bins in order to maximise reuse and recycling.
- Compared with landfill, the charge for waste taken to recycling depots was a minimum of 20% cheaper.
- Workers drank from mugs and used metal teaspoons instead of disposable cups and wooden stirrers. Dispensers were installed for coffee, tea, sugar and soap.
- Accurately estimate only the necessary amounts of materials required rather than the traditional approach of ordering extra quantities to allow for wastage.
- Waste materials were separated and recycled wherever practical and economical. Over one-third of the total waste volume generated was recycled.
- By implementing recycling and waste minimisation measures the total volume of waste was reduced by 15%.
- Financial savings of 55% were achieved on waste removal costs.

NIAGARA MOHAWK POWER CO USA

In 1990, Niagara Mohawk Power Corp installed a photovoltaic system on the roof of a commercial building in Albany, New York, to see if such a system would produce energy precisely when needed most i.e. on hot, humid summer afternoons when there is a peak power demand for air conditioning.

Niagara Mohawk believes it has validated the use of photovoltaics as a technically viable demand side management option, even in a geographic location receiving only 51% of available sunlight each year (Paraphrased from http://www.caddet.co.uk/).

The installation comprises a 15.4 kW photovoltaic array mounted on a tracker that allows the panels to remain at an optimum angle to the sun all day.

The photovoltaic system is sized so that its output will not exceed the building's electrical demand (peak electrical load is 570 kW, base load is 325kW).

Since July 1990, the photovoltaic system has met all of its design specifications, and its peak shaving ability has exceeded expectations. Project performance details are described below:

- The installation comprises a 15.4 kW photovoltaic array of 70 polycrystalline ribbon silicon flat-plate panels, each 1.2m (4 ft) by 1.8m (6 ft), with a total area of 156m² (1,680ft²).
- These panels are mounted on three single-axis tilting frames that passively track the sun on a horizontal north-south axis, which allows the panels to remain at an optimum angle all day, thus creating maximum electrical output.
- The direct current is fed into a state-of-the-art DC to AC combined inverter/power conditioning system. The photovoltaic system is sized so that its output will not exceed the building's electrical demand.
- The photovoltaic system was installed on time and within budget, and has had no major equipment or operations problems. A computerised data acquisition system polls 50 sensors every 10 seconds and stores 10-minute averages of all parameters.
- Since July 1990, the photovoltaic system has met all of its design specifications, and its peak shaving ability has exceeded expectations. The system operated at 93% of its rated capacity for the 1990 peak building load.
- For the top 300 building loads since July 1990, the system operated at 65% of its rated capacity. The system generated more than 24,500 kWh (88 GJ) an amount of energy that would require approximately 20,000 pounds (9,070kg) of coal or 2,000 gallons (7,570 litres) of oil.
- The project cost $800,000US and was funded primarily by Niagara Mohawk, with a contribution from the Empire State Electric Energy Research Corp.
- Niagara Mohawk believes the project demonstrates that for each megawatt generated by photovoltaic systems in its service area, up to 363,000kg of coal or 322 m3 of oil can be displaced each year, thus reducing carbon dioxide emissions by more than 2.3 million kg, sulphur dioxide emissions by more than 90,700kg, and nitrous oxide emissions by more than 13,600kg per year.

SKANDIA ASSURANCE, STOCKHOLM, SWEDEN

The project involved a renewed lighting system of a corridor, a conference suite and 10 separate offices (http://www.caddet.co.uk/. The project data is summarised below:

- The old system comprised 42 fluorescent fittings with installed power of 3.0 kW. Furthermore, there were bulbs and compact fluorescent fittings of 1.1 kW. about 3.2 kW was in the office rooms and 0.9 kW in the corridor.
- The new installation comprises 38 efficient fluorescent fittings with electronic ballasts with installed power of 2.4 kW.
- The power of new bulbs and compact fittings is 0.5 kW. Altogether the installed power is 2.9 kW, from which 2.2 kW is in the office rooms and 0.7 kW in the corridor.
- The lighting circuits provide individual control of each fitting. Alternatively, one single circuit can control several fluorescent fittings. It is possible to reprogram lighting simply by separate push buttons or a control panel and adjust the lighting according to the changing situation of room layout and work tasks with out expensive recabling. This can be done without the knowledge of the technical details of the system.
- Corridor presence detectors, which switch the light on, when somebody enters into the room and off when the room is left empty, were installed in all rooms. Furthermore, two office rooms were equipped with light sensors that measure the influx of daylight to ensure that indoor lighting levels remain constant.
- Energy consumption was measured before and after installation. The results show, that the use of lighting just by the actual needs reduces the energy consumption of office rooms by 55% and in the corridors by 20%. The total savings were about 40%.
- The system is applicable for theatres, public auditoriums and sports arenas, etc.
- The installation comprises Fagerhult 3x36 BC fluorescent fittings. The intelligent Helvar LP lighting system is based on Neuron 3120 microcircuits installed in electronic ballasts and Neuron 3150 microcircuits installed in push buttons that were manufactured by Motorola.
- The constant light detector used was a Helvar LP LSMO type and the presence detector was a PDIF type.

Table of Energy Data (for the lighting only)

Area/Data	**Consumption**		**Savings**		
	(kWh/year)	**(kWh/m2)**	**(%)**		
	Before	**After**	**Before**	**After**	**Total**
Office rooms	4000	1800	21.6	9.7	50
Corridor	3000	2400	22.2	17.8	20
Total	7000	4200	21.9	13.1	40

- About 11% from the total 40% savings, is made by Helvar LP system and 29% is made by more effective fluorescent fittings equipped with electronic ballasts.

5 IMPEDIMENTS AND SOLUTIONS

5 IMPEDIMENTS AND SOLUTIONS

The following table indicates various impediments to implementing ESD initiatives in buildings (as typically found in discussions with building design and environmental management professionals).

Table 6. Types of Impediments to ESD in Buildings

Organisational	Reduced priority assigned to ESD. Appropriateness in terms of user comfort, technology and architectural philosophy. Lack of appreciation of the benefits. Lack of accessible information; and doubts about affordability.
Physical	Site layout and size. Reflectivity of adjoining development can increase heat loads. Reduced solar access in areas of higher density. Privacy issues. Parking requirement policy that may encourage private vehicle use. Heritage items –if the building is for adaptive re-use, heritage provisions may restrict the implementation of ESD principles. Natural ventilation, particularly in higher density environments can be an issue. There is a need to ensure that intake sources are receiving 'clean air' i.e. adjoining A/C outlets of adjoining buildings are not near intake vents.
Educational	Lack of awareness of the benefits among consumers/general public when a building is constructed with environmentally appropriate materials.
Training	Lack of information for suitable training for personnel.
Operation and Maintenance	Incorrect operation of the heating, cooling and ventilation system can result in 10 to 30% energy wastage (Doggart et al 1997). EECA (1997) audited 197 office buildings in New Zealand and found they exceeded the expected energy use of 396 MJ per square metre by 100% (i.e. actually consuming 792 MJ per square metre). This was due to control errors, poor maintenance and lack of communication between designers, owners, managers and tenants. Similar results could be expected for buildings designed with energy, water and waste efficiency in mind. The outcome will depend on the level of awareness and commitment of the owners, managers and tenants and also on systems complexity.

The following table shows practical solutions to impediments as identified above.

Table 7. Solutions

Design	Multidisciplinary approach required. Use of non-build solutions and existing infrastructure (modified if necessary) where possible.
Technical	Recognise the contribution that behavioural change can make. Recognise that each project has individual circumstances.
Financial	Life cycle costing can indicate substantial savings over the life of the building, through material choice, waste management, water and energy efficiency.
Planning	Subjective decision-making can be improved with the use of life cycle assessment.

6 SELF-ASSESSMENT CHECKLISTS

CHECKLIST FOR PLANNING PHASE

CHECKLIST FOR DESIGN PHASE (INCORPORATING DOCUMENTATION AND PROCUREMENT)

CHECKLIST FOR CONSTRUCTION AND DISPOSAL PHASE

CHECKLIST FOR USE PHASE (INCORPORATING OCCUPANCY AND EVALUATION)

6 SELF-ASSESSMENT CHECKLISTS

CHECKLIST PHASES

In reviewing case studies, many initiatives in planning and design have failed to be communicated effectively to the correct people, at the appropriate time. It is critical that solutions to ESD issues and project implementation involve appropriate people at the right time.

To ensure consistency across various management approaches, a life cycle method has been adopted for the following checklists:

- **Planning**;
- **Design** (incorporating Documentation and Procurement);
- **Construction and Disposal** (combined in checklist because of common activities); and
- **Use** (incorporating Occupancy and Evaluation).

The checklists are formatted for ease of reference throughout key phases of the fitout process. Recommendations have been combined under lifecycle phases. Accordingly, some recommendations may exceed the maximum rating of 5.

Considerations and outcomes in key performance areas are grouped according to each profession's responsibility and capacity to ensure appropriate and timely implementation. At each phase of the fitout, those responsible for implementation of work may use the checklists to report on initiatives undertaken, improvements and lessons learned in the key performance areas. While activities in each phase differ, the same system is used in each checklist. This approach promotes and facilitates an integrated outcome.

Stakeholders likely to be involved include project planners, designers, suppliers, contractors, demolition teams, builders, as well as owners and occupants e.g. post-occupancy evaluation.

Although checklists were developed primarily to facilitate communications and awareness, they are equally useful in planning and tracking all activities. The checklists also support auditing, checking and corrective actions.

CHECKLIST FOR PLANNING PHASE

Consideration	Implementation Activity	Rating
Awareness and Education		
Encourage participation	Facilitate and report on surveys and responses of occupant needs/special needs Client input is canvassed and ESD objectives promoted.	3 2
Inform and educate on ESD issues	An environmental management plan is developed. An ESD approach is promoted and selections justified.	1 3
Review Best Practice ESD initiatives	Best practice ESD outcomes are researched for outcomes of: • Increased reliance on renewable energy sources; • Enhanced passive design and daylighting; • Promoting efficient energy use and waste avoidance; • Increased reliance on renewable materials; • Increased materials-recycled content and recyclability; and • Enhanced water efficient use and waste avoidance.	 1 1 1 1 1 1
Equity and Access		
Provide equitable access	The fitout will comply with AS 1482 parts 1 and 2. Provision is made for special needs of parents/carers of infants.	3 6
Environmental Health Protection		
Protect endangered species	Certified plantation timbers are preferred and specified.	3
Understanding of churn factors	Master plan promotes heritage protection/flexibility in future use. Plantings are used to improve "high churn" work areas**.**	1 1
Resource Conservation		
Ensure design flexibility	Plan future flexibility in Master Plan of space available.	2
Enhance reliance on renewable energy sources	Clients/tenants are informed about green power scheme and cost effective renewable energy options recommended, including grid-tied photovoltaic arrays and solar hot water systems.	4
Enhance energy efficiency	Selection of 5-star appliances is promoted and recommended.	1
Waste avoidance	Energy targets and highest efficiency, cost-effective tariffs are to be researched and proposed. Energy audits are conducted to establish energy targets and power density efficiency.	4 5
Promote waste avoidance	Education on waste avoidance and recycling is promoted. A best practice waste management plan is developed.	1 1
Best Practice rubbish removal	Plan for recycling to industry best practice standard.	1
Use of recycled material	Increased recycled content is specified throughout the project.	4
Security		
Identify security/and health issues	Potential risks assessed in consultation with client OH&S Officer. A risk management plan is developed.	3 3
Maintenance and Cleaning		
Promote responsible cleaning	Promote applicator's best organic cleaning practice to client.	1
Record materials compositions	Obtain, review and provide records of material safety data sheets for all materials and cleaning products.	5
Identify fitout cleaning practice	All product records of manufacturer recommendations for low impact cleaning agents are collected and provided.	4
A central vacuum cleaning system	Viability and operational requirements of central vs. current vacuum cleaning arrangements are investigated.	1
Electrical/Data Communications		
Electro magnetic fields	Fields near plant, electrical risers and sub-boards are checked.	2
Ventilation air handling/conditioning		
Provide quality fresh air	Opportunities for increasing fresh air volumes are identified.	1
Lighting		
Enhance reliance on efficient use of energy	Intelligent lighting control; low energy lights; motion detectors applied to switches in low occupancy areas are considered.	3
Mechanical Services		
Base building services	Performance contracting is promoted.	1
Hydraulic Services		
Consider source options	Collection of fresh bore/rain water is considered where permitted.	1
Re-use of grey water	A water discharge environmental management plan is developed. Consider treating or recycling grey water by installing a diversion valve and drainage to a collection tank for re-use.	1 1
Reduce black water	Consider composting-toilets where permitted and practical.	1
Records Management		
Accurate fitout records	The fitout record system is developed for future retrieval/re-use.	1

CHECKLIST FOR DESIGN PHASE (INCORPORATING DOCUMENTATION AND PROCUREMENT)

DESIGN PHASE

Consideration	Implementation Activity	Rating
General Environmental Health Protection		
Protect endangered species	Appropriate species and certified plantation timbers are selected. Specifications require plantation sources only in timber throughout.	1 4
Provide indoor plantings	Plant placement is <3m from light of 400-850 nm wavelength.	1
Promote cleaner production	Use of polyvinylchloride is minimised wherever practical. Preference is given to bio plastics over synthetic plastics.	5 5
Minimise sources of toxic fume in case of fire	Where practical use of PVC coated or based fabrics and trims near potential ignition/heat sources are avoided.	3
Select natural fabrics	Use of Fire Retardants containing VOCs is minimised.	1
Pest management	Crevices and spaces for pest/vermin nesting are avoided.	1
General Resource Conservation		
Increase reliance on sustainable material sources	Coir, wool, sisal, jute and linoleum finishes are promoted. Wool, cotton, silk, hemp and cane material is promoted. Synthetic composite materials are minimised. Reliance on petrochemical derivatives is minimised. Recycled timber/metal is used rather than virgin, where practical.	5 5 5 5 1
Promote waste avoidance	R-use of existing furniture and fittings is promoted.	1
Design for recycling and re-use	Spaces for recycling bins are provided in layout. Recycled doors, glass and joinery are incorporated in the design.	1 1
Maximise design flexibility and understanding of churn factors	Standard material sizes are adopted in design solutions. Options for re-use are provided e.g. design for disassembly. Design for portability/permanence depends on change history.	1 3 1
Waste avoidance	Packaging is reduced and recyclability promoted.	1
Increase durability in system	Pull/push plates are promoted if required on painted surfaces. Design includes guardrails in high delivery/use corridors/corners.	1 1
Reliance on recycled/and recyclable materials	Where possible, recycled glass and doors are used. Recycled plastic is used for most signage. Components are designed for reuse/recycling/deconstruction with e.g. mechanical rather than adhesive fixing. Vending machines reliant on disposable cups are avoided.	2 1 5 1
Passive Design		
Waste avoidance	An appropriate Building Energy Rating System is applied.	1
Maximise daylight sources	Design/maintain space near windows to optimise daylighting. Installations that maximise daylight but reflect UV/IR include: • lightwells/shelves; • laser cut panels or alternative glazing; and • high-level reflectors/diffusers.	5 3 3 5
Enhance wise use of energy	Planned light zones reflect occupant use/proximity to daylight. Natural ventilation options are recommended where appropriate.	1 2
Consider daylight control	To reduce glare at source, use of glazing films is exploited; Reflectivity of surfaces near windows is considered; Reflectance levels on computers/VDUs are controlled.	1 1 1
Understand thermal issues	Occupant thermal comfort is assured by establishing: • effect of window and orientation/regional locations; • thermal loadings of each; • liaison with consultants on heat/air flows before locating workstations near windows; and • that external shading is proposed if heat loads are excessive. Application of lighting and thermal simulation tools is considered.	 2 1 1 1 1
Maximise passive design opportunities	Open working spaces are positioned within 7m of windows. Offices are located near building core & open areas near windows. Meeting rooms are located internally if block out is required. Windows are exploited to maximise daylight to occupant areas.	3 1 2 3
Furniture Design		
Minimise building hazards	Sharp edges to furniture/fittings/joinery are avoided.	1
Select natural fabrics	Organic high-flame resistant and low toxicity fabrics are used.	2
Waste avoidance	Cupboards are designed for re-use and relocation. Place-specific custom design joinery is minimised.	1 1
Waste management	Access is provided for ease of maintenance of all services. Standardised modular furniture is specified. Fixed furniture is avoided.	1 1 1

Partition/Wall Design		
Maximise design flexibility	Design shows modular, demountable, freestanding partitions and furniture throughout.	7
Minimise hazards	Doors contain vision panels where appropriate.	1
Enhance wise use of energy	Opening windows and partition systems do not clash.	1
Promote waste avoidance	Use of demountable and re-usable partitions is specified.	1
Design for Floor Coverings		
Minimise building hazards	Non-slip flooring is used. At floor level changes/transitional thresholds contrasting colours to stairs are used along with tactile indicators as appropriate.	1 3
Promote cleaner production principles	Alternative material to vinyl/lowest PVC content in floor coverings is specified.	5
Increase reliance on sustainable sources	Coir, wool, sisal, jute and linoleum flooring is promoted. Timber flooring is from plantation/managed forests only.	1 4
Increase system durability	Easy-to-replace carpet tiles are used rather than fixed carpet. There are appropriate wet weather areas for ingress/egress.	1 1
Increase use of recycled/ recyclable materials	Recycled tyre matting is considered where appropriate. Carpet is selected from manufacturers who recycle their product.	1 5
Design for Security		
Identify security and health issues	Pre-wiring of proposed security systems is denoted. Food storage areas and rubbish bins are separated in kitchen.	1 3
Maintenance and Cleaning		
Promote responsible cleaning	Recommended best organic cleaning practice is promoted.	1
Provide indoor plantings	Trays protect carpet/joinery from moisture ingress. Appropriate access for watering/replacing plants is provided. The maintenance program is recorded for the Handover Manual.	1 1 1
Electrical/Data Communications		
Consider electro magnetic fields (EMF's)	EMF fields at plant; electrical risers & sub-boards are considered. Any fluorescent task lights to be fixed >30cm from occupants. If appropriate select liquid crystal display computer screens.	1 1 1
Ventilation air handling/conditioning		
Identify chemical storage areas	Storage/shared ventilation paths for chemicals/food are avoided. Adequate ventilation to cleaning stores/cupboards is provided.	1 1
Optimise airflow	Air-intakes, registers and exhausts are identified.	1
Optimise natural venting	Ventilation flow rates are established for occupancy rates	1
Provide quality fresh air	The system capacity for fresh/recirculated air is investigated. Liaison with consultants/maintenance A/C staff.	1 1
Increase reliance on ambient air intake	Use of 100% outside air at certain times/periods is investigated. Reliance on outside ambient air is recommended when practical.	1 1
Lighting		
Enhance reliance on efficient use of energy	Intelligent lighting control systems are considered. Motion detectors are fitted to switches in low occupancy areas. An intelligent lighting system controls lighting in daylight. Separate switching of all lighting around windows is provided. Single high efficiency tubes replace twin tubes where appropriate. Low voltage lighting is used with dimmers. Fluorescent, rather than incandescent fittings are proposed. Spectral reflectors are recommended in fluorescent lamps to avoid discomfort in sensitive occupants/high churn areas.	1 1 5 4 1 3 1 1
Hydraulic Services		
Use efficient plumbing fittings and appliances	Ensure design promotes: • water saver showerheads (max flow rate 9.5 litres/min); • aerators to kitchen/laundry/basin water spouts; • efficient, instantaneous hot water rather than storage systems; • ceramic discs to plumbing fittings; • flick mixer rather than individual taps; • low water use appliances and checking of consumption to compare options. Water diverter spout with a shower over a bath. Replacement of toilet cisterns relies on dual flush systems.	 1 1 1 1 1 1 1 1
Design for maintenance	All fittings and pipe runs are accessible for maintenance.	1
Records Management		
Accurate fitout information	Fitout design records are prepared to assure effective operations.	1
Reduce transport energy	Research on and selection of lowest transportation/embodied energy content of imported product lines is on record.	1

DOCUMENTATION AND PROCUREMENT PHASE

Consideration	Implementation Activity	Rating
Procurement - General		
Environmental Health Protection		
Protect endangered species Appendix B	Plantation timbers with origins recorded are specified throughout. Reference to appropriate species selection listing is specified. Use of tropical hardwoods is avoided unless it is recycled.	3 5 5
Provide indoor plantings	Plants that filter toxins, are free of pests, disease or toxic chemicals, and contribute to local habitat are specified.	3
Promote cleaner production	Alternatives to vinyl or lowest PVC content are specified throughout i.e. in cabling and blinds.	11
Minimise toxic materials	All product's material safety data sheets (MSDS) and manufacturer's recommended safety procedures are called for and examined.	1
Minimise VOCs in material used	All relevant MSDs are reviewed to ensure avoidance of exposure to: Benzene, Formaldehyde and Toluene compounds; plus synthetic and natural aromatic organic solvents.	 3 1
Resource Conservation		
Increase system durability	Optimum wear/life expectations are specified for key elements.	1
Reduce transport energy	Procurement of increased local content is specified. Bulk materials are specified to be from nearest native source.	1 1
Use of recycled material	Increased recycled content is specified.	5
Waste management	Time and space for sorting materials is specified. Space for waste bins is specified. Off site cutting of all materials is specified. Reduction and recyclability of packaging is specified.	1 1 1 1
Allow for recycling and re-use	It is specified that nominated demolished materials be sorted and recycled.	5
Furniture/Equipment		
Minimise sources of toxic fume in case of fire	Avoidance of CFC and polyurethane foams as well as PVC to furniture is specified. Avoidance of fire retardants containing VOCs is specified.	3 1
Select natural fabrics	Organic fabric with high flame resistance/low toxicity is specified.	1
Maintenance and Cleaning		
Low impact practice	Low impact cleaning recommendations for all elements are specified.	1
Electrical/Data Communications		
Energy efficiency	Selection of 5-star appliances is specified.	1
Waste avoidance	Initialising of equipment power-saver-mode programs is specified. Soft wiring and flexible data systems are specified.	1 1
Ventilation air handling/conditioning		
Fresh air quality	Air-conditioning system capacity for fresh/recirculated air is noted.	1
Lighting		
Enhance reliance on efficient use of energy	In fluorescent fitting high frequency electronic ballasts are specified. Lighting levels to corridors and lobbies are minimised. High efficiency fluorescent tubes & silver tint reflectors are specified.	1 1 1
Minimise toxic material	Lowest level mercury in tri phosphor light tubes is specified.	1
Mechanical Services		
Base building services	The expected life of mechanical plant/fittings is recorded. Mechanical services/maintenance contracts are noted.	1 1
Hydraulic Services		
Healthy water quality	Decay, fungal growth, etc. is checked in water storage tanks/pipes.	1
Pressure regulation	Specifications call for fixings that prevent water hammer.	1
Black water avoidance	A water discharge environmental management plan is on hand.	1
Control paint effluent	It is specified that final paint washouts occur away from site.	1
Records Management		
Identify/record toxic items	Safety information on removal of suspicious material is provided. Procedures for correct asbestos removal are provided for vinyl tiles, A/C heater banks; fibro sheeting, ceiling components and insulation.	1 5

CHECKLIST FOR CONSTRUCTION AND DISPOSAL PHASE

Consideration	Implementation Activity	Rating
Disposal		
Audit hazardous materials within base building	Relic surfaces and materials are tested for presence of lead and asbestos. Safety information on removal of suspicious material is noted. Risks are identified and assessed in Hazardous Materials Audit.	2 5 1
Security and health issues	The risk management plan is reviewed and updated. Check all product material safety data sheets.	1 3
Waste management	Time and space is allocated for sorting materials near waste bins.	1
Ensure Best Practice rubbish removal	Best practice recycling options are determined and provided for all masonry, concrete, timber, paper, plastics, glass, and metals. Recovery of materials for recycling/re-use is recorded and reported.	1 1
Allow for recycling/re-use	Easy access for waste removal for recycling is provided.	1
Increase reliance on recycled/and recyclable materials	Wherever possible, all glass, steel studs and plasterboard are recycled. All metal shopfront/partition/window components are recycled. Materials are sorted at demolition prior to despatch.	3 5 5
Construction		
Identify security and health issues	Consultation occurs with client OH&S Officer to assess potential risks. Tenancy occupation is reviewed and co-ordinated with construction. Secure separation of construction and occupied areas is specified. The risk management plan is recorded, reviewed and updated.	1 1 1 1
Protect occupants from construction impacts	Where required, doorways to occupied areas are taped and sealed. Filters to all air-conditioning intakes and exhausts are provided. Sanding of plasterboard on site is avoided. Negative air pressure zones to minimise dust transfer are provided. Outside air intake/outlet is used in A/C supply construction areas. There is consultation with consultant and contractor.	1 1 1 1 1 1
Reduce black water	Solvent cleaning in sinks is avoided.	1
Control effluent of construction	A 'cover-sleeve' process to avoid daily paint washout is used. Liquid/percolated waste is kept out of the drainage system.	5 1
Avoid restricted delivery on site	To ascertain access for long/sheet materials lifts are measured. Any restrictions to site delivery are identify and negotiated. Planning minimises delay both on site and during delivery. Supply is scheduled to avoid over estimates of material quantities.	1 1 1 1
Waste management	A best practice waste management plan is adhered to.	1
Plan Best Practice rubbish removal	Mobile bin storage in accessible spaces is planned. Recovery of materials for recycling/re-use is recorded and reported.	1 4
Security		
Identify security and health issues	Tenancy occupation is reviewed and co-ordinated with construction. Secure separation of construction and occupied areas is monitored.	1 1
Maintenance and Cleaning		
Protect occupants from construction impacts	All surfaces are thoroughly clean on handover. High efficiency (H.E.P.A) filters are specified in vacuum cleaning. Ceiling spaces, ductwork/ceiling tile surfaces are vacuum cleaned.	1 1 1
Promote responsible cleaning	The maintenance program and manufacturer recommendations for use of natural cleaning products are included in Handover Manual.	1
Consider pest management	All joints and service penetrations are effectively sealed and checked. A pest management protocol is included in Handover Manual.	4 2
Electrical/Data Communications		
Waste avoidance	Surge detectors are installed to avoid accidental damage/waste.	1
Ventilation air handling/conditioning		
Cleaner production	Alternative or lowest PVC content is used in conduit and ducting.	3
Provide quality fresh air	A purge air cycle during fitout construction is proposed.	1
Hydraulic Services		
Avoidance of black water	The water discharge environmental management plan is implemented.	1
Records Management		
Identify/record toxic items	The result of the Asbestos audit is recorded. Records show identification PCB capacitors in fluorescent lighting. Records show the removal of lead paint according to approved procedures.	1 1 1
Enhance local content	Records show manufacturing location of specified items.	1

CHECKLIST FOR USE PHASE (INCORPORATING OCCUPANCY AND EVALUATION)

Consideration	Implementation Activity	Rating
Awareness And Education		
Encourage participation	Responses to pre and post occupancy review of fitout are facilitated.	1
Inform and educate on ESD issues	Improved outcomes/lessons are reported to clients/occupants. ESD report cards are used and contributed to tenant education.	5 1
Assess outcomes of ESD initiatives	A consultant is engaged to audit and report on: • Increased reliance on renewable energy sources; • Enhanced passive design and daylighting; • Efficient energy use and waste avoidance; • Increased materials-recycled content and efficient distribution; • Increased reliance on renewable materials and durable systems: • Water efficient use and waste avoidance; and • Volatile Organic and Reactive Organic Compounds.	 1 4 2 3 3 4 3
Maintenance and Cleaning		
Identify cleaning practice	Low impact cleaning recommendations for all elements are on record.	1
Electrical/Data Communications		
Consider electro magnetic fields (EMF's)	To ensure compliance EMF fields are checked near air-conditioning plant; electrical risers and all adjacent sub-boards. Staff not placed directly behind unshielded computers. Fluorescent task lights are >30cm from all occupants.	 1 1 1
Waste avoidance	The power saver mode program is initialised on all equipment.	1
Ventilation air handling/conditioning		
Provide quality fresh air	Opportunities for increasing fresh air volumes are identified.	1
Optimise natural ventilation	Ventilation flow rates for occupancy rates are checked. Compliance report from commissioning personnel is checked.	1 1
Optimise airflow	No occupant work areas are placed directly under vent drafts.	1
Waste avoidance	AC ventilation mode is used during appropriate ambient conditions. Checks ensure air conditioning thermostats suit aspect/occupants.	1 1
Lighting		
Efficient use of energy	Light switches are labelled and show areas of control/function.	1
Hydraulic Services		
Consider source options	Reliance on bottled water supply is avoided.	1
Water pressure	All outlets are checked to ensure there is minimum water splash.	1
Maintenance	Leaking taps and cisterns are listed for immediate rectification.	1
Ensure water health Quality	Water storage tanks/pipes are checked for decay, fungal growth etc.	1
Reduce black water	Grates and strainers are provided to all kitchen sinks.	1
Mechanical Services		
Base building services	The expected life of mechanical plant/fittings is on record. Mechanical services/maintenance contracts are noted.	1 1
Records Management		
Identify security and health issues	The risk management plan is recorded, reviewed and updated. Information about special needs of occupants is noted.	1 1
Identify/record toxic items	Records show locations of any old smoke detectors. Safety information on removal of suspicious material is noted. Asbestos audits are recorded.	1 3 1
Protect endangered species	Both origins of certified plantation timbers and species are noted.	1
Provide equitable access	Compliance to AS 1482 parts 1 and 2 is checked and reported.	3
Enhance operations with accurate fitout information	The fitout record system for future retrieval and re-use is implemented. Existing access/egress plans including visitors safe access and emergency procedures are distributed. Material safety data is collated & procedures noted from all suppliers. The Handover Manual includes ESD information, is formatted for ready reference and has been distributed and reviewed. To prevent accidental scalding, the specific upper limit of hot water temperature and the compliance report is in the Handover Manual.	1 1 1 1 1
Promote waste avoidance	Identify recycling options to client in Handover Manual.	1

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GLOSSARY OF TERMS

SELECTED REFERENCES

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GLOSSARY OF TERMS

Air emissions: A description of physical quantities and chemical character of air emissions over a life cycle.

Bio Plastics: Plastics made from plant materials such as Cellulose. Bio Polymers or Bio Plastics can also be produced by micro-organisms.

Built Heritage: A place or a building with aesthetic, architectural, historical, scientific, social or technological significance to the community.

Burden: The quantitative value assigned to any input or output (having physical quantity and chemical character) for a given product or productive system**.**

By-product: A useful product that is not the primary output of a productive process or system.

Certified Timbers: Timbers certified by the Forest Stewardship Council (FSC) - an international non profit organisation founded in 1993 which has introduced a labelling scheme for forest products.

CFC - Chlorofluorocarbons: Compounds used as coolants in refrigerators and air conditioners and in the manufacture of some foam plastics, solvents and dry cleaning agents which contribute to the stratispheric ozone layer depletion.

CHURN: The moving of staff and rearrangement of office space.

Comparative assertion: A claim regarding the environmental superiority or equivalence of one product versus a competing product that performs an equivalent function.

Construction waste: A description of physical quantities and physical character of solid construction waste (*with known or unknown chemical character*).

Co-product: A marketable by-product from a process or system. This includes materials that may have been called waste e.g. scrap, but is useful as raw materials in a different manufacturing process.

Cover-sleeve: A process where used brushes/rollers are covered and re-used rather than cleaned between each application.

Cultural heritage: National, regional and local culture of community groups making up the community.

Elementary flows material or energy:

- entering the system being studied, which has been drawn from the environment without previous human transformation e.g. from air land or water.
- leaving the system being studied, which is discarded into the environment without subsequent human transformation e.g. to air, land or water.

Embodied Energy: The combined energy required to extract raw materials from processing to erection including transportation calculated to compare one material to another.

Environmental burden: The total releases of pollutants of different classes to the environment.

Emissions: All outputs of an operation that have no commercial value including all to air, land and water.

Environment: Surroundings in which an organisation of living things functions, including affected air, water, land, natural resources, flora, fauna, communities and habitat interrelations, that extends from inside to outside that organisation to the global system.

Environmental Aspect: Element of an organisation's activities, products or services that can interact with the environment.

Environmental Audit: Systematic, documented verification process of objectively obtaining and evaluating audit evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with audit criteria, and communicating the results of this process to the client.

Environmental Impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Environmental Management System (EMS): Part of a management system including organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining environmental policy.

Environmental Objective: Overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where practicable.

Environmental Performance: Measurable results of the EMS related to an organisation's control of its environmental aspects, based on its environmental policy objectives and targets.

Environmental Policy: A statement by an organisation of its intentions and principles in relation to its environmental performance in a framework for action for setting environmental objectives and targets.

Environmental Target detailed performance requirement, quantified where practicable, applicable to the organisation arising from environmental objectives to be set and met to achieve those objectives.

Functional Unit: The quantified performance of a product system for use as a reference unit in LCA.

Gross energy requirements: A description of how energy is utilised during the defined life cycle of a product, whether as solar flux, daylight, thermal load, a fuel, or as electricity, or as a feedstock.

Gross raw materials requirements: A tabulation of the total quantity of raw materials associated with each operation during the defined life cycle.

Handover Manual: A document prepared by a designer or facilities manager identifying important information on the project including services details, warranties of equipment and commissioning information.

Hazardous Materials Audit: A review of toxic and hazardous materials contained in a building’s structure, equipment and fittings.

Input: Material or energy which enters a unit process. Materials include raw materials and products. Specific environmental burdens entering a system from the environment include resources and energy.

IR: Infra red.

Life cycle: Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal.

Life cycle assessment (LCA): The compilation and evaluation of inputs, outputs and potential environmental impacts of a product system throughout its life cycle.

Life cycle costing: An approach to cost analysis which brings economic impacts at a future time into the decision making process.

Natural heritage: Continental indigenous flora fauna, land and water.

Operation: A defined step, or steps, within an industrial process flow.

Organic: Originating from natural sources either plant or animal based.

Organic Fabrics: Fabrics comprising substances from animals or plants avoiding the use of Petro Chemical substances.

Output: Material or energy which leaves a unit process including raw materials, intermediate products, products, emissions and waste including environmental releases of emissions to air, water, and land.

PCB - Polychlorinated Biphenyls: Non flammable, stable and electrically insulating chemicals. Used in capacitors and cooling fluids which can accumulate in the body and are carcinogenic for animals.

Pollution Prevention: Use of processes, practices, materials or products that avoid, reduce or control pollution, which may include recycling, treatment, process changes, control mechanisms, efficient use of resources and material substitution.

Product System: Collection of materially and energetically connected unit processes that perform one or more defined functions and this includes product systems as well as service systems.

Process: An operation performed on one or more raw materials or intermediates leading towards the production of a product.

PVC – Polyvinylchloride: Polyvinylchloride plastic is a soft resin made stronger with cross-linking agents. Combustion products are high in carcinogenic vinyl monomer, corrosive hydrochloric acid, toxic carbon monoxide and low in carcinogens known as dioxins.

Raw material: A primary or secondary (e.g. recovered and/or recycled) feedstock used in a subsequent manufacturing process.

Recycling: Set of processes for reclaiming material, that would otherwise be disposed of, as a material input to a product or service system.

Renewable resource: Natural resource that is capable of regeneration**.**

SF6: Sulphur hexafluoride used in tests of airflow.

System: A group of operations which, when acting together, perform a defined function. In a life cycle inventory, the scope of the system is defined by the boundary conditions.

Transparency: Open, comprehensive and understandable presentation of information.

UV: Ultra violet energy.

VDU - Visual Display Unit: Associated with computer screens.

VOC's - Volatile Organic Compounds: substances that readily release vapours at room temperature or below both by evaporation from the volatile liquids and by off gassing from many synthetic solids.

Waste: Any output from the product system with no marketable value that is disposed of in releases to the environment via air, water, and land. It has no beneficial use and is returned to the ground.(e.g. landfill or incineration).

Solid wastes: A description of the quantities and types of solid wastes produced during the defined life cycle of the product.

Water emissions: A description of the quantities and types of water emissions during the defined life cycle of a product.

APPENDICES

APPENDIX A INTRODUCING THE BUILT ENVIRONMENT PROTOCOL

A healthy and sustainable built environment is required to use, conserve and enhance the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased. The Built Environment Protocol was developed in line with existing state, national and international agreements and was formally launched in Brisbane on 5 December 1997.

Background

The Protocol forum aimed to establish a new direction for Community, Government and Industry organisations to enable them to work together towards a healthier and sustainable built environment. It harnessed the knowledge, skills and energy of the participants and the organisations they represented, to establish broad consensus on directions and development of policy and procurement guidelines for:

- working towards a healthier and ecologically sustainable built environment;
- striving for continuing quality improvement to reduce risks associated with known hazards; and
- engaging with industry to improve ecologically sustainable trade and employment prospects.

Outcomes from the CGI-97 Forum

There was consensus about the need:

- for effective communication across a wide range of people about the problems and challenges posed in the built environment; as well as
- for a nationally integrated effort to promote and co-ordinate activity on strategically planned outcomes;
- to develop the capacity to make critical judgments about the real benefits and costs of current approaches to building design, building technology and building management; and
- for our knowledge base and technical development to be well matched to the demands of the times in which we live.

Scope

The forum reviewed the need to:

- improve building materials, processes, products and systems;
- improve management of known occupational and environmental health risks;
- reduce environmental health risks associated with harmful emissions to air, land and water;
- assess tools to identify and promote ecologically sustainable products and practices;
- improve sustainable asset management in design, purchasing, maintenance and disposal;
- improve performance, audit and corrective action;
- plan for healthier indoor environments via improved product and service performance;
- reduce impacts of buildings on the local, national and global environments; and
- include all urban and remote residential, commercial, institutional and industrial buildings.

Principles

The Protocol was founded on existing principles for healthier and ecologically sustainable development in the built environment. Directions developed relied on decision analysis and management strategies based on equity, biodiversity, precautionary and true cost principles that provide the basis for and enable organisations to work towards an ecologically sustainable built environment.

Recognition of the Partnership Roles

The CGI-97 Forum recognised the need to establish the partnership roles for working towards further consensus and integration of effort. This requires communication with the parties concerned to develop an ongoing understanding of the roles of each organisation including the:

- Community's role as users of the built environment, strategic partners and clients;
- Government's role to act in the public interest to promote a national approach and be an exemplar of asset management services; and
- Industry's role as builders, researchers, developers, designers and technology owners.

The Built Environment Protocol

Statement of Direction

We will strive to ensure the Australian community works and lives in a healthy and sustainable built environment today and tomorrow. Our mission is to provide direction and enable Community, Government and Industry organisations to work together towards a healthier and sustainable built Environment. It is essential for the health and economy of the nation to:

- provide direction for future integration of effort; and
- engage with industry to improve ecologically sustainable trade and employment prospects.

Driving Principles

To achieve a healthy and sustainable built environment we need new directions to enable Community, Industry and Government organisations to use, conserve and enhance the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased. We seek to challenge and enable organisations to:

- Protect the earth's resources for the benefit and use of future generations;
- Ensure equitable sharing of the earth's resources and opportunities amongst present generations;
- Err on the side of safety when in doubt about the environmental impact of an activity;
- To recognise significant environmental health risks in the built environment and manage strategies to avoid them;
- Protect other species and replenish populations that are threatened;
- Ensure that the price of products and services reflects true life cycle costs of protecting and restoring the natural and built environment and health (human and ecological); and
- Better understand health impacts of the built environment (internal and external) so guidelines for improvement can be developed and implemented.

Challenges that we face

In the Australian built environment we have:

- Depletion of freshwater resources;
- Pollution of surface and ground waters; and
- Soil erosion and pollution as well as pollution of urban air

to an extent that is detrimental to human and ecosystem health.

On a global scale we have:

- Habitat deterioration and destruction; and
- Climate change and depletion of scarce natural reserves.

The challenge is to accept the seriousness of the problems we face and the urgency of addressing them. The key to ensuring a healthy and sustainable relationship between buildings, their occupants and the wider environment is to improve our:

- Interactive communication;
- Understanding;
- Knowledge base; and
- Technical development.

This is particularly so in planning, design, purchasing, construction, management-in-use and disposal phases in buildings.

Working Together to Meet These Challenges

We have convened a task force to establish communication around Australia, which recognises and develops the roles and partnership of Community, Government and Industry organisations, leading to a nationally integrated effort. We support continuing review of elements of this Protocol and an overall review every three years.

Outcomes of this Protocol

We seek a nationally integrated effort and support for participating Community, Government and Industry organisations to ensure:

- consistency of approach to issues based on the aforementioned principles;
- improvement towards ecologically sustainable built asset management in planning, design, purchasing, maintenance and disposition for minimising resource use, wastage and emissions to air, land and water;
- development of national strategies for communication and education, additional professional codes of practice and guidelines along with national advice channels to the public;
- approaches and technologies which benefit the health (human and ecological) and sustainability of the built environment including the development of environment design tools and guidelines;
- improved databases and information to identify and promote ecologically sustainable products and practices; and
- recognition of achievement of participating organisation.

APPENDIX B SPECIFYING SUSTAINABLE USE OF TIMBER

Distinguishing between environmental impacts from use of 'good' and 'bad' timber is a complicated task. Not all rainforest or primary forest timber is bad and not all plantation timber is good. Certification is a system used to separate the "good" timber from the "bad". It involves an assessment of a forest management system and an audit trail to trace "eco" labelled timber products from certified, well-managed forestry operations to the point of sale. The internationally recognised Forest Stewardship Council (FSC) has criteria for certification. A governing body comprising representatives from environment, industry and indigenous groups administers the Council. Specifications are the key guidelines used by builders.

General Specifications

- Specify for certified plantation timber and use only products fabricated from forest-friendly sources.
- Specify avoidance of timbers from at risk forests or eco-systems.
- Specify only products and processes with widely accepted impacts and results.
- Specify to allow easy disassembly for reuse or recycling.
- Use the minimum grade that meets performance requirements.
- Specify for recycled timber especially for wood that is rare or comes from at-risk habitats.
- Specify against the use of rainforest timber in formwork and scaffolding.
- Specify for engineered (plantation and recycled) wood products.
- Specify provision of copies of certification where products are procured from recycled sources.
- Specify that substitution alternatives require the prior written approval of all relevant parties and ensure the right of veto over replacement timbers.

The Use of Preservative

The use of preservatives raises an important issue: the introduction of toxic compounds to supplement non-durable timbers rather than using naturally occurring durable species. Toxic treatments such as Copper Chrome Arsenate (CCA) are far from ideal, especially where there are arguably superior alternatives. However, the effects of their use can be a better understood risk than the loss of native forests where most durable timbers grow.

- Specify avoidance of CCA treatments where possible.
- Specify minimum levels of preservative to meet performance requirements: Ref AS 1604.
- Specify appropriate disposal of preservatives if used on site.
- Specify minimum environmental health impact methodology with any toxic chemicals on site.
- Specify the preservatives used on site must be disposed of according to local authority requirements.
- Specify no burning on site of any surplus treated timber.

Delivery, Storage and Handling

- Specify to reduce waste, minimise fungal attack and deterioration by careful storage/handling.
- Specify the protection of framing, sheathing, and engineered products from excessive moisture.

Indoor Air Quality

- Specify lowest levels of allergenic organisms through limiting conditions that encourage growth.
- Protect framing from moisture during construction and allow framing to dry before enclosing.
- Specify minimised known allergens, including formaldehydes linked to 'sick-building syndrome'.
- Maximise ventilation and encourage pre-occupancy venting and testing prior to occupancy.
- Select material to exclude formaldehydes in resins and adhesives.

Carpentry Specifications

- Potential sites for rot and termite entry are to be designed out with careful detailing.

Specify the elements

- Refer to grades and use of timber grades.
- Use natural round poles (refer to *The SAA Timber Structural Code AS1720.1-1988 Part 1 Table 2.2*).
- Use recommended physical termite barriers and minimise requirement for chemical barriers.
- Consider the use of finger-jointed timber where it meets performance requirements.

Engineered Wood Products

- Consider engineered wood products with improved span/weight ratios and dimensional stability.
- Specify low impact glues, metal joining and low-impact non-wood fibres in timber composites.

A Comparison Between Engineered Wood Products

Product	Constituents	Advantages	Disadvantages
Hybeam	Softwood ply, phenolic adhesives.	High span-to-weight ratios.	Use of phenolic resins makes recycling difficult.
Posi-struct	Radiata pine, galv steel.	High span-to-weight ratios.	Hybrid construction makes reclaiming materials difficult.
Particleboard	Softwood chip, phenolic resin.	Use of timber by-product, cost-effective span system.	Use of phenolic resin makes recycling difficult. Off gassing.
MDF board	Softwood pulp, phenolic resins.	Use of timber by-product, cost-effective span system.	Use of phenolic resin makes recycling difficult. Off gassing.
Glue Lam beam	Various timbers, phenolic resins.	High-strength, effective use of timber, offers larger sizes.	Use of phenolic resin makes recycling difficult.
Finger-jointed beam	Various timbers, phenolic resins.	Maximum use of timber, generally superior dimensional tolerance.	Minimal use of glues makes this product more suitable than most for re-use.

APPENDIX C CLEANER PRODUCTION ALTERNATIVES

Various alternative materials are available for flooring, electrical and information cables, guttering, underground drainage and cladding. Careful analysis is required to determine comparative assertions about environmental impacts of an application including those in maintenance and disposal because results vary with transport distance, design life and service delivery requirements. Alternatives adopted for a variety of reasons are shown below.

Pipes and Ducting

Rigid piping for above and underground drainage or carrying electrical cables and gas include:

- Durable, chemical resistant vitrified clay pipe not needing a granular bedding for sewage or water;
- Polyethylene or ductile iron pipes used in mains renovation and in new sewage schemes;
- High density polyethylene (HDPE) used for sewage pipes as it is flexible and shock resistant;
- Medium density polyethylene (MDPE) pipe that is gaining market share in the water industry;
- Zinc, cast iron, copper, steel or aluminium for above ground drainage, soil/vent pipes and guttering; and
- Polyethylene (PE) and steel used for ducting carrying electricity cables.

Electrical Cables and Wiring

Manufacturers produce halogen-free cable including:

- Polyethylene insulation/sheathing and rubber sheathing for high and medium voltage applications;
- Polyethylene or rubber insulation for low voltage applications; and
- Polypropylene and polyethylene data transmission cables.

Floor Coverings

Competitively priced and comparably performing floor coverings include:

- Acrylic sealed linoleum that is anti-static, sound absorbent, resistant to fats/oils and has low flammability;
- Durable rubber products such as ethylenepropylenediene used in airports and sports stadiums;
- Wood that can be a very durable option as it can be renovated by planing or sanding; and
- Durable, sound absorbent, naturally resilient cork sealed with chlorine free sealants.

Building Membranes

For waterproofing applications, tensile structures, roof membranes, and geomembranes alternatives include:

- Canvas and silicone-coated fabrics useful for tensile or stressed fabric structures;
- Ethylenepropylenediene monomer rubber roof membranes that may be safer than PVC for workers to weld; and
- Rubber geo-membranes used in landscaping and civil engineering.

APPENDIX D RATING GREENHOUSE PERFORMANCE OF COMMERCIAL BUILDINGS

Demonstrate your greenhouse performance to your employees, customers and clients, and create a competitive advantage for your business.

Introduction

The Building Greenhouse Rating Scheme (for office buildings) is a voluntary program, designed to enable building owners, managers and tenants to identify ways in which greenhouse performance can be improved and gain market recognition for superior greenhouse performance. Star ratings can be awarded for the base building (central services), a tenancy or the entire building. The ratings are based on energy-related greenhouse gas emissions, adjusted to account for climate and building use. The more stars, the better the performance. The rating methodology and software-rating tool enables self-assessment. However, you can only promote the rating if a SEDA assessor officially reviews it and you pay the appropriate fees. *For further details, contact SEDA www.seda.nsw.gov.au or PO Box N442 Grosvenor Place NSW 1220 ph 92915260 fax 9299151.*

Why worry about greenhouse gases?

The 'greenhouse effect' refers to a blanket of gases that trap the sun's warmth in the earth's atmosphere. Although a natural phenomenon, recent human activity has meant that the concentration of greenhouse gases, particularly carbon dioxide (CO_2), has increased significantly in the atmosphere. This is likely to have a serious impact on global climate, including an increase in temperature and in the incidence and severity of weather events. Australia has committed to reducing its emissions of greenhouse gases.

Why rate commercial buildings?

Australian commercial buildings generate about 35 million tonnes of CO_2 each year as a result of the energy they consume. With business-as-usual, these emissions are estimated to almost double by 2010. Rating your building will help you identify your potential to reduce greenhouse emissions and compare your performance to others.

How does the rating work?

The star rating is derived from the actual amount of energy (electricity, gas, coal or oil) you consume in a year. This means the rating reflects the way energy is managed, as well as how efficiently the building is designed.

Why rate greenhouse performance and not energy efficiency?

It is the greenhouse impact of building operation that is critical. The greenhouse impact is determined by both the amount and the type of energy used. Different types of energy such as gas, cogeneration and renewables are all less greenhouse-intensive energy sources than coal-generated electricity. By rating the greenhouse performance, the scheme encourages all strategies for reducing greenhouse emissions, not just energy efficiency improvements.

How can I improve my rating?

There are many cost-effective ways to improve your rating. Energy efficiency improvements can be as easy as introducing Energy Star office equipment or tuning your existing building management system. Initiatives like this are good investments, and will continue to save you money. Combining energy efficiency improvements and greener fuel sources makes even more sense. If you invest at least some of your savings from efficiency improvements in opting for a less greenhouse-intensive energy source, you can reduce the greenhouse impact of your building significantly and still improve your bottom line.

Can Green Power improve my rating?

Green Power is a national accreditation scheme for electricity generated from renewable sources. There are no greenhouse emissions associated with Green Power so it offers a way of improving your rating without the need to spend capital. However, Green Power will cost more than conventional electricity, so unless you combine it with energy efficiency measures, you might spend more on energy consumption.

Should tenants seek 5-star buildings?

When looking for new office space, ask your prospective landlord how well the base building rates. A greenhouse rating can help you compare building performance, and you should seek the highest rating possible. As a guide, a 3-star building is performing very well in today's marketplace.

Will I have to pay more for a building or office with a good rating?

A good greenhouse rating shouldn't cost more. A high rating will reflect an efficient building, with low operational costs and energy consumption.

Can I trust this rating?

The rating method was developed by SEDA in conjunction with industry representatives. The documented methodology is available for you to review. SEDA provides an official rating only after an official validation process.

What about new buildings?

In addition to the official performance rating, SEDA is also developing a 'commitment rating', which will apply if you're designing a new building or planning a refurbishment and wish to commit to reaching and maintaining a particular greenhouse rating. You will soon be able to use an official commitment rating to promote your new or upgraded building.

How much does a rating cost?

You can self-assess your building or tenancy at no cost. Just download the rating tool from the SEDA website. However, to obtain an official rating you will need to contact SEDA. An official rating will cost around $600 for a typical office, although, larger buildings may cost more depending on floor area. The fees are negotiable and vary according to circumstances, such as site size, the number of sites or repeat ratings. Fees are charged to recover the costs of the official assessment and promote the scheme.

What do the stars mean?

- Exceptional Best building performance
- Excellent Current market best practice
- Very Good Strong building performance
- Good Average building performance
- Poor Poor management/outdated systems

What the industry is saying

"The Building Greenhouse Rating Scheme shows that investors can equally pursue corporate and environmental goals in the pursuit of more ecologically sound cities." **Peter Verwer, Chief Executive, Property Council of Australia;**

"This scheme will shift the focus of the building industry from a first capital base mentality to one of life cycle efficiency. Clients will now be provided with quantifiable evidence that it is far better in their commercial interests to construct a well performing building than it is to build something that is simply cheap." **John Murray, National Executive Director, Master Builders Association;**

"ABEC is keen to work with SEDA in encouraging broad industry support. The Council is prepared to work with SEDA, relevant State bodies and authorities and other interested organisations, in examining the feasibility of extending the scheme nationally at an appropriate time." **John Wells, Executive Director, Australian Building Energy Council (ABEC);**

"The Building Greenhouse Rating scheme is a positive step in encouraging the commercial building sector to embrace energy efficiency and become more environmentally responsible energy users. As a leader in promoting energy efficiency and the use of renewable energy, we believe the scheme has the potential to significantly reduce Greenhouse gas emissions in the commercial building sector." **Paul Broad, Managing Director, Energy Australia**;

"Reducing the amount of energy used in both the production and operation of buildings is a major issue for architects. On adopting a comprehensive environment policy in the early 90's, the Royal Australian Institute of Architects set out to develop a key reference and resource for building design professionals in the form of the Environmental Design Guide that is now operated by the Australian Council of Building Design Professions. Therefore the RAIA welcomes SEDA's initiative and offers its support for the implementation and development of the Building

Greenhouse Rating Scheme. The RAIA believes this voluntary code will be a valuable adjunct to future regulatory reform aimed at reducing greenhouse gas emissions." **Ric Butt, Past President, Royal Australian Institute of Architects;**

"AIRAH National already has a co-operative agreement with the Greenhouse Challenge Office and our members are ready to assist building owners and tenants implement this innovative development of the NSW Government." **Cees Lommers, National President, AIRAH.**

Worked Examples

Town Towers Building/Tenancy)

Town Towers, a 20-storey office building in central Sydney, has a single tenant. When the lease came up for renewal, the tenant approached the manager to find out how well the building was performing. The manager believed the base building was reasonably efficient, but decided to use SEDA's rating tool for self-assessment and apply for an official Building Greenhouse Rating to show the building's performance to the tenant.

Steps to the stars

The tenant, knowing that the building's inefficiency would mean higher-than-necessary outgoings, said a 1-star rating would not be good enough. Faced with the possibility of losing an excellent tenant, the manager commissioned an energy audit to improve the building's rating.

Improving energy efficiency

The audit identified that better air-conditioning controls would save over $60,000 p.a. with a capital outlay of $150,000. This improvement meant a significant reduction in greenhouse emissions and a 3-star rating for the building.

What about Green Power?

The manager could also have achieved a 3-star rating by purchasing 30% of the electricity as Green Power (generated from renewable sources). Green Power is more expensive so relying on it to raise the building's rating would add $35,000 p.a. to ongoing energy costs (based on extra Green Power costs of 4 cents/kWh). Alternatively, combining the two approaches by converting to 30% Green Power while investing in energy efficiency, would attract a 4- stars rating for the building with a total saving of $32,000 p.a. The manager invests in an official 4-star building rating to keep his tenant and saves $32,000 p.a. on energy bills!

- Initial rating: 1-star; Energy use: 385 MJ/m² p.a. @ $12.05/m² p.a.; CO_2: 148kg/m² p.a.
- Energy efficiency improvement rating: 3-star; Energy use: 615 MJ/m² p.a. @ $9.05/m² (saving$60K p.a.); CO_2: 114kg/m² p.a.
- Using Green Power (154 MJ) and energy efficiency Rating: 4-star; Energy use: 615 MJ/m² p.a. @ $10.05/m² p.a. and CO_2: 88kg/m² p.a.

Capital Court Building

For this 10,000m² owner-occupied office building, a strategy combining energy efficiency improvements and investment in Green Power can achieve 5-star greenhouse performance in five years and cut energy costs by more than 40%.

Steps to the stars

The owner-occupier of Capital Court employs a new building manager, who has the specific task of achieving a 3-star greenhouse rating within three years and a 5-star rating within five years, without increasing operating costs.

Year 1

The new manager immediately commissions an energy audit of the building to identify all opportunities to lower greenhouse emissions. Within two months, all the no-cost or low-cost energy initiatives are implemented. This includes enabling Energy Star features on office equipment and turning off lights at night. Result: 20% reduction in energy use. Cost: One-off cost equivalent to 5% of annual energy cost ($1.44/m²). By investing half the energy savings in Green Power (with no greenhouse emissions), the building manager can exceed the three-year target and reach a 4-star rating within one year - but still save on energy costs. Result: With a surcharge of 3 cents/kWh, an investment of $2.47 (half of $4.94) means that 82 kWh/m²/yr can be Green Power.

Year 2

Despite the prospect of favourable returns the building owner has little available capital for investment in building upgrades this year. The manager decides to look into the possibility of an Energy Performance Contract for a lighting upgrade. This means no capital outlay for the owner, but the savings will be shared with the performance contractor for 10 years. Result: 15% reduction in energy use (saving $3.80/m² 2) Cost: Half savings ($1.90/m²) for 10 years' Net savings: $1.90 (this year) + $6.40 (from year 1) = $8.30/m²/yr. The extra efficiency means Green Power can be cut back to 45 kWh (costing $1.35/m²/yr) while still maintaining a 4-star rating. Net savings: $8.30 (see above) $1.35 (Green Power) = $6.95/m²/yr.

Assumptions: Monthly peak demand charge: $6.50/kW; peak electricity cost: 5 cents/kWh; off-peak electricity cost: 3 cents/kWh; Green Power surcharge: 3 cents/kWh; greenhouse coefficient of standard electricity: 1.0kg CO_2/kWh; assumed average electricity cost for standard building:

9 cents/kWh; assumed value of saved energy (mostly saved during peak periods): 10.0 cents/kWh.

Initial performance rating: 1-star.

Energy use: 320 kWh/m²/yr; Energy cost: $28.80/m²/yr; CO_2: 320kg/m²/yr.

Efficiency measures and 30% Green Power Rating: 4-star.

Energy use: 256 kWh/m²/yr; Energy cost: $24.55/m²/yr; CO_2: 25-82=174kg/m²/yr.

Lighting upgrade and less Green Power Rating: 4-star.

Energy use: 218 kWh/m²/yr; Energy cost: $21.85/m²/yr; CO_2: 21-45=173kg/m²/yr.

Year 3

The chiller in the air-conditioning system is upgraded after equipment failure. The building manager takes the opportunity to install variable-speed fans and high-efficiency motors at the same time, funding the difference between the base cost and the high-efficiency option with another performance contract (the contractor will receive half the savings for 10 years). Result: 20% reduction in energy use (saving $4.30/m²). Cost: 50% of savings ($2.15/m²) for 10 years. The extra efficiency means the 4-star rating can be maintained without the need to invest in Green Power. Capital Court is now saving more than $100,000 a year on energy costs, and is developing a reputation as a model of good energy management. Net savings: $2.15 (this year) + $8.30 (ex years 1 and 2) = $10.45/m²/yr.

Year 4

The owner sees promotional benefits in running a 5-star building and directs the manager to invest some of the operational savings in Green Power. This means the 5-star rating can be achieved a year ahead of schedule. In the meantime, the manager plans further efficiency improvements for implementation next year. Cost: 70 kWh of Green Power at 3 cents per kWh=$2.10/m² Net savings: $10.45 (ongoing) $2.10 (extra Green Power)=$8.35/m²/yr.

Year 5

Ongoing building upgrades and improvements to office equipment efficiency mean the building can cut back on its Green Power purchase to 0kWh to still have a 5-star rating.

- Result: Save 15% reduction in energy use (saving $6.50/m²);
- Cost: Half savings ($3.25/m²) for 10 years;
- Net savings: $3.25 (this year) + $10.45 (ongoing);
- $1 (for higher standard of maintenance and operational management) =$12.70/m²;
- An official 5-star performance rating allows Capital Court to demonstrate the success of the company's initiatives to staff, customers and the community.

The future

As a 10,000m² building, Capital Court could achieve savings of more than $125,000 every year with this strategy. And the strategy has meant reducing annual greenhouse emissions by one-third - from 3,200 tonnes per year to only 1,100 tonnes a year. The high level of energy efficiency now being achieved also means that the owners of Capital Court could make a corporate commitment to zero emissions by moving to 100% Green Power-and still save more than $90,000 p.a. on energy bills. Once performance contracts have expired, the savings would increase even more.

- Air-conditioning upgrade and no Green Power Rating 4 Star.
- Energy use: 175 kWh/m²/yr; Energy cost: $18.35/m²/yr; CO_2: 21-45=175kg/m²/yr.
- 40% Green Power Rating: 5-star.
- Energy use: 175 kWh/m²/yr; Energy cost: $20.45/m²/yr; CO_2: 17-70=105kg/m²/yr.
- Ongoing upgrades/no Green Power Rating 5-star.
- Energy use: 110 kWh/m²/yr; Energy cost: $16.10/m²/yr; CO_2: 110kg/m²/yr 100%.
- Green Power Rating: 5-star.
- Energy use: 110 kWh/m²/yr Energy cost: $19.40/m²/yr; CO_2: 0kg/m²/yr;(NB savings increase when performance contracts expire.

Shedding Some Light

The following whole-building greenhouse rating is for the City Administration Centre at 282 King St Newcastle. Operating 45 hours/week, 237 occupants used 5,445m²/yr. The historical performance rating was 1-star with an energy consumption of 1148 MJ/m²/yr; and normalised CO_2:287kg/m²/yr. The current performance rating is 2-star with energy consumption now 894 MJ/m²/yr and normalised CO_2: 223kg/m²/yr.

Steps to the stars

Newcastle City Council cut the amount of energy used by its administration centre by improving the efficiency of its fluorescent lighting systems. Improvements included: An intelligent light switching system with local area control for timed switching after hours;

- Low-loss ballasts;
- Troposphere fluorescent tubes;
- Removal of 1 lamp from 3-lamp luminaires;
- Automatic sensor controls on lighting in toilets; and
- Centralised power factor correction system.

The total investment was $101,500. As well as significant ongoing savings (worth $67,000 every year and a 40% reduction in energy costs), the upgrade also resulted in improved lighting quality and lower maintenance costs. Greenhouse Gas was reduced by nearly 350 tonnes per year, raising the Greenhouse Rating from 1 to 2-star.

What next?

The council plans to install an air-conditioning economiser, which will optimise the use of fresh outside air and reduce the energy needed to maintain a comfortable interior temperature. This will help the council further improve the building's greenhouse rating and continue to demonstrate its commitment to sound economic and environmental management.

"When we started out we were targeting a 10% reduction in energy costs," says Peter Dormand, Co-ordinator of Newcastle's Green Energy Project. "Now that we have learned how easy it is to save money from this activity we have *raised our goal to a 60% reduction. We are confident we can achieve this level of saving because we now realise how wasteful our energy use has been in the past."*

A Suite of Stars

Lend Lease set out to design and construct an efficient building when it commenced work on Darling Park. In Stage 1 (Base building greenhouse rating) the building size of 60,708m² operated 90 hours a week with energy consumption of 588 MJ/m²/yr and normalised CO_2: 80kg/m²/yr.

Steps to the stars

The building was completed in 1993. A 4-star greenhouse rating demonstrates that Lend Lease effectively combined efficient design and a commitment to energy management. Key features that have made Darling Park a 4-star complex include:

- a floor plate design that minimises heat gain from the western sun while still allowing plenty of light into the building;
- sun hoods that further reduce heat gains; and
- good air conditioning/lighting design; and
- a sophisticated building management system.

What next?

Darling Park Stage 2 is almost ready for tenancy. Lend Lease has built on the success of Stage 1, utilising the same floor plate together with high performance glass, light shelves and sun-

shading to promote daylight penetration while reducing the heat load of direct sunlight. These features will certainly facilitate a superior star performance.

Aurora Place (88 Phillip St Sydney)

Aurora Place will be a showcase of energy efficiency and exceptional greenhouse performance if Lend Lease's plans for the new development are realised. The 48,700m² office building will incorporate all the latest technologies and world's best practice in innovative and efficient design. According to Mark Menhennitt, Director, Technical Services Group, , "*Lend Lease believe the rating tool will highlight the benefits of good design to the community, and will serve to promote public awareness of greenhouse gas production. We believe the increase in awareness will promote initiatives such as energy efficient design and cleaner energy sources. As industry leaders, Lend Lease see the rating scheme as way to promote our point of difference."*

APPENDIX E ASSESSMENT OF MATERIALS FOR ESD

Australian designers and architects are now using embodied energy and life cycle assessment (LCA) tools to deal with upstream issues such as resource depletion and downstream issues such as pollution abatement and waste avoidance. The range of LCA and embodied energy decision support tools can be useful to identify impacts of built environment activities on natural reserves and air, water and land quality.

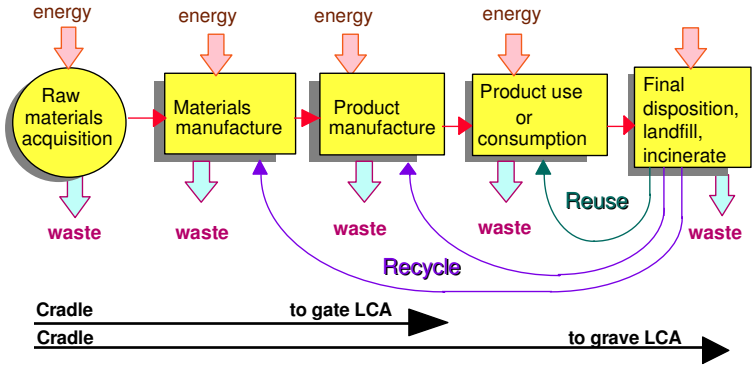
Traps For New Players

Various leading industry and research initiatives have produced recent, accurate/credible, representative and effectively sourced Australian databases. Much care is required when making comparative assertions about different products from different sectors to ensure true comparisons are made. While skilled analysts can provide both rigorous and effective comparative assessments, the risk of others getting it wrong is high because of the uncertainties in data age, scope, accuracy and sources. Indeed there is, as yet, no nationally accredited Australian environmental impact database available for comparative assessment of building materials.

The Scope of these Guidelines

A cradle-to-grave LCA or embodied energy analysis starts with raw materials from the earth, ends with the final disposal back into the earth and includes environmental burdens associated with manufacturing, transport and use. The processes depicted in Figure 1, a process flow chart, all have material, energy inputs and waste and recycling outputs to consider for environmentally responsible approaches.

Figure 1.



This Guideline has taken a cradle to end of life approach rather than the limited cradle to gate approach found in embodied energy lists. Considerations based on such lists should not be adopted ahead of those of durability, fitness for purpose, recycled content or recyclability, as these can be more important. It is common to see invalid materials selection based on lowest embodied energy. An example is provided below to show where errors may be made when comparing e.g. steel, aluminium, polymers and timber materials.

Example to Consider:

Aluminium is often quoted as having one of the highest embodied energy per tonne of building material, as it is four times more than steel. Nevertheless, aluminium is typically:

- 2.7 times lighter than steel: so, if a density-based comparison is made of embodied energy we find that aluminum is about 1.5 times that of steel.
- more corrosion resistant than many steel products: so, in an exterior coastal zone application aluminium can have a design life of 40 years against say 20 years for some steel.

When considering embodied energy plus durability and density, the embodied energy of aluminium may be shown to be 0.75 that of steel. The comparison need not stop there. By considering the recyclable content, a steel product may become preferable in many applications because domestic structural steel is often made using electric arc furnaces that can produce almost 100% recycled content. Also, steel for roofing and cladding products is usually made in basic oxygen furnaces that rely on some recycled scrap feedstock.

These same considerations can also apply to polymers, timbers other metals and other materials where maintainability/durability can be prime concerns.

APPENDIX F PROCEDURES TO REDUCE CONTAMINATION OF INDOOR ENVIRONMENT

Volatile Organic Compounds (VOC's) require control in terms of use as construction materials. Interpretation of indoor VOC concentrations is difficult due to the lack of health-based guidelines for most indoor pollutants found in non-industrial indoor environments. For these reasons it is essential to apply the following process wherever possible.

Recommended Procedures

Step 1:

Evaluate and select low VOC impact building materials and products.

Step 2:

Pre-condition materials prior to installation to minimise emission of VOC's after occupation. There is no field data demonstrating the minimum length of time needed to effectively pre-condition various building products. However it is recommended that vinyl resilient flooring, carpet and fabric-covered elements be laid out and aired to release volatile emissions, for three weeks prior to delivery to site. At no time should PVC based packaging or protective covers be used.

Step 3:

Install building materials and products based on their VOC emission decay rates: Wet products should be installed first. Porous materials, such as carpets and fabric-covered office partitions should be installed last to reduce the absorption of VOC's that will re-release over the lifetime of the fitout.

Step 4:

Whenever practical, ventilate a building during and after the installation of new materials and products. Flush-out for at least 60 hours or longer prior to occupation. Identify people with chemical sensitivity, monitor their response and develop strategies to protect against high exposure. If practical, conduct sensory evaluation testing to ensure occupants are not exposed to levels of VOCS that give rise to fumes which can cause headache, dizziness, nausea or irritation of the membranes of the eyes and nose.

Step 5:

Delay occupancy until VOC concentrations have been reduced adequately. Occupants exposed to high levels of VOC's may become sensitised and thereafter, suffer responses to even low levels of such compounds.

Materials that dry quickly should be preferred to slow-drying materials, if they are functionally equivalent and similar in performance. Caution is required, however, as some quick-dry products may form an early seal (rapid or flash set) but release significant levels of VOC's for a longer period throughout their performance life. Incorporate the above principles into project delivery programs and specify as a requirement of the builder in construction process and programming.

Adhesives, sealants and caulks: Use physical not chemical fixing where possible

Specify physical connections, to at least the minimum amount of adhesive, sealant and caulking compounds necessary for satisfactory completion of each installation task. Require that adhesives have the lowest practical content of toxic or irritating VOC's while meeting other performance requirements. Require that manufactures of adhesives, sealants, and caulks submit results of emission tests as well as drying times and conditions for each product. Ensure maximum ventilation is supplied during and after application of these materials e.g. by leaving doors open.

Fireproofing

Use shaped fittings around pipes to ensure walls are effectively fire resistant in preference to spray-on materials that act as a source of and sink for pollutants.

APPENDIX G PROCEDURES TO REDUCE EMISSIONS FROM INSTALLATION OF FLOOR COVERINGS

Underlay

For carpet underlay, typically use exterior grade plywood or formaldehyde free particleboard in preference to low-density panels made of recycled paper or standard particleboard, as both are rich sources of formaldehyde emissions.

Particle board

When using flooring and walling, made with particleboard, obtain and compare formaldehyde emission details from manufacturers. If emission-testing results are not available, look for manufacturers using 'European standard' board as that has lower emissions. Alternatively, use board rated 'exposure one' under US emission rules.

Fixing Carpet and Resilient Floor Coverings

Where possible, avoid adhesives by using physical fixing. For good indoor air quality, it is always a better choice to use nail strips and avoid any gluing. If glue must be used, water or low-toxic low-volatile based varieties are generally safer for both the installer and occupants of the space. Ensure only the minimum quantities of low VOC impact adhesives are used.

Carpets

Wherever practical, use physical fastening systems to eliminate or minimize reliance on chemical adhesives. Always allow three weeks for off-gassing from new carpet (either off or on site prior to installation), with good ventilation and vacuuming prior to occupancy. Low-emission carpets e.g. fusion bonded backing, are preferable.

Resilient flooring

There is a wide range of resilient flooring available that provides comparable physical and environmental performance. Minimum vinyl content products should be preferred as an alternative to high vinyl products such as synthetic and natural polymers such as polyolefin, linoleum, copolymers.

The significant issues in selecting resilient flooring are numerous and relate to:

- wear-resistance;
- integrity and durability of joint sealing;
- longer-term hygiene at edges and backing;
- renewable resource content; and
- recommended sealer and cleaning chemicals.

Where practical, it is preferable to select natural polymers such as linoleum, or synthetic polymers high in polyolefin, polypropylene, polyethylene, over high vinyl content product. When compared with other polymers, vinyls have many times the embodied energy and polluting emissions in manufacture, use and disposal.

Ceramics/stone/timber/resilient flooring etc

Seal only with low VOC silicone and water-based acrylic sealers.