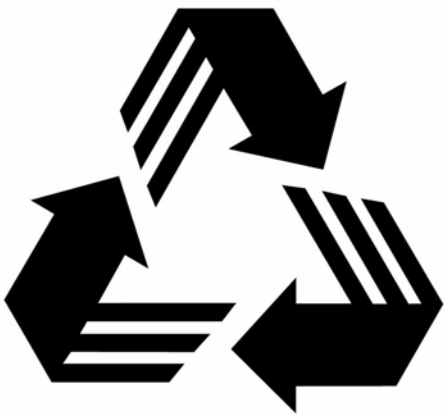
Sustainable Construction

What does it all mean?



Source: City of Melbourne, CH2 building

What is Sustainability?

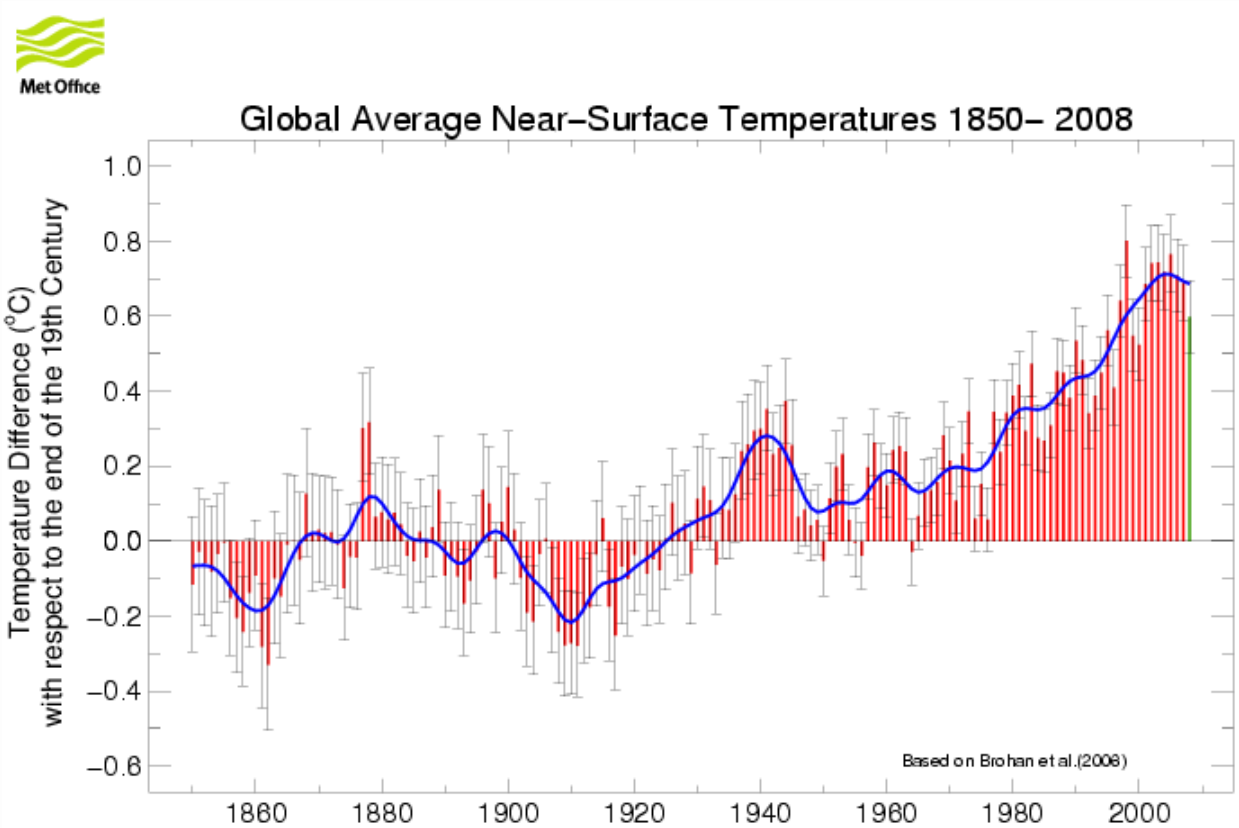
- United Nations World Commission on Environment and Development (1987):

Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their need.

Ref: World Commission on Environment and Development (1987), Our Common Future, Oxford University Press.

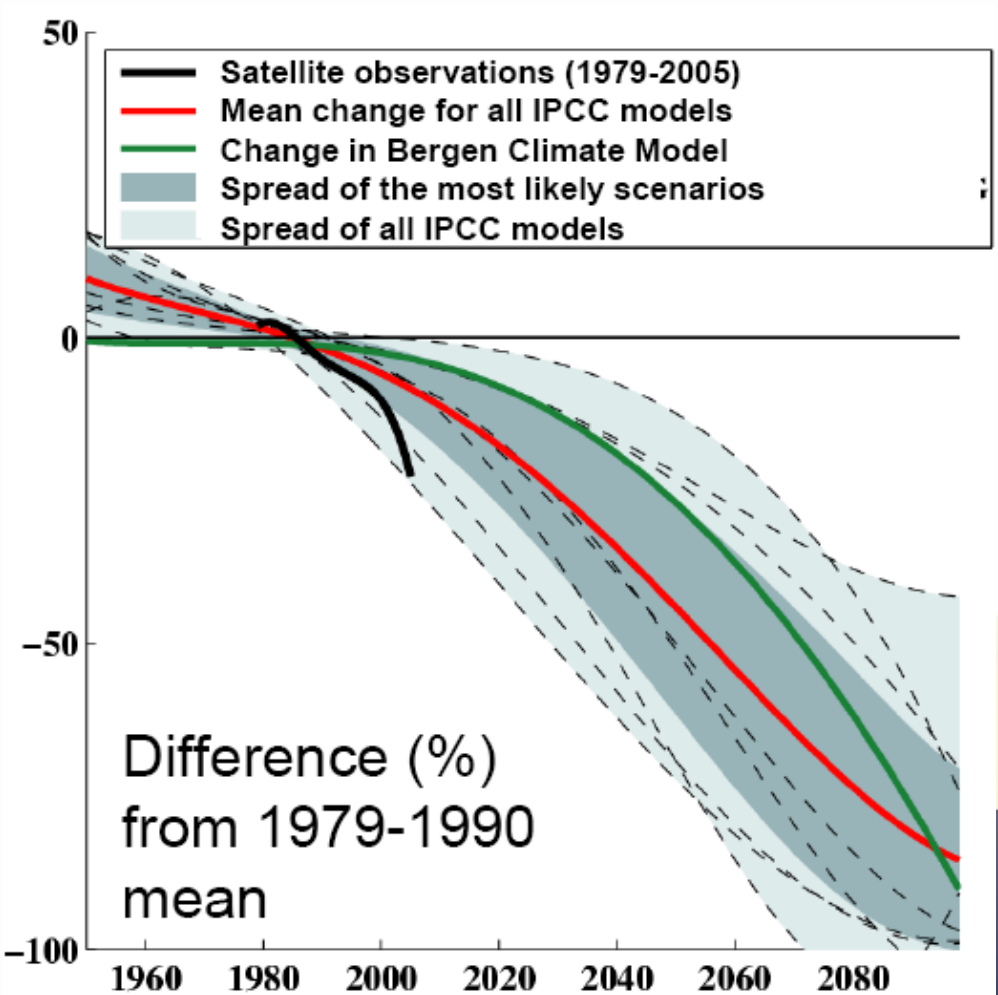
The environmental impacts of construction and use of buildings

Climate change



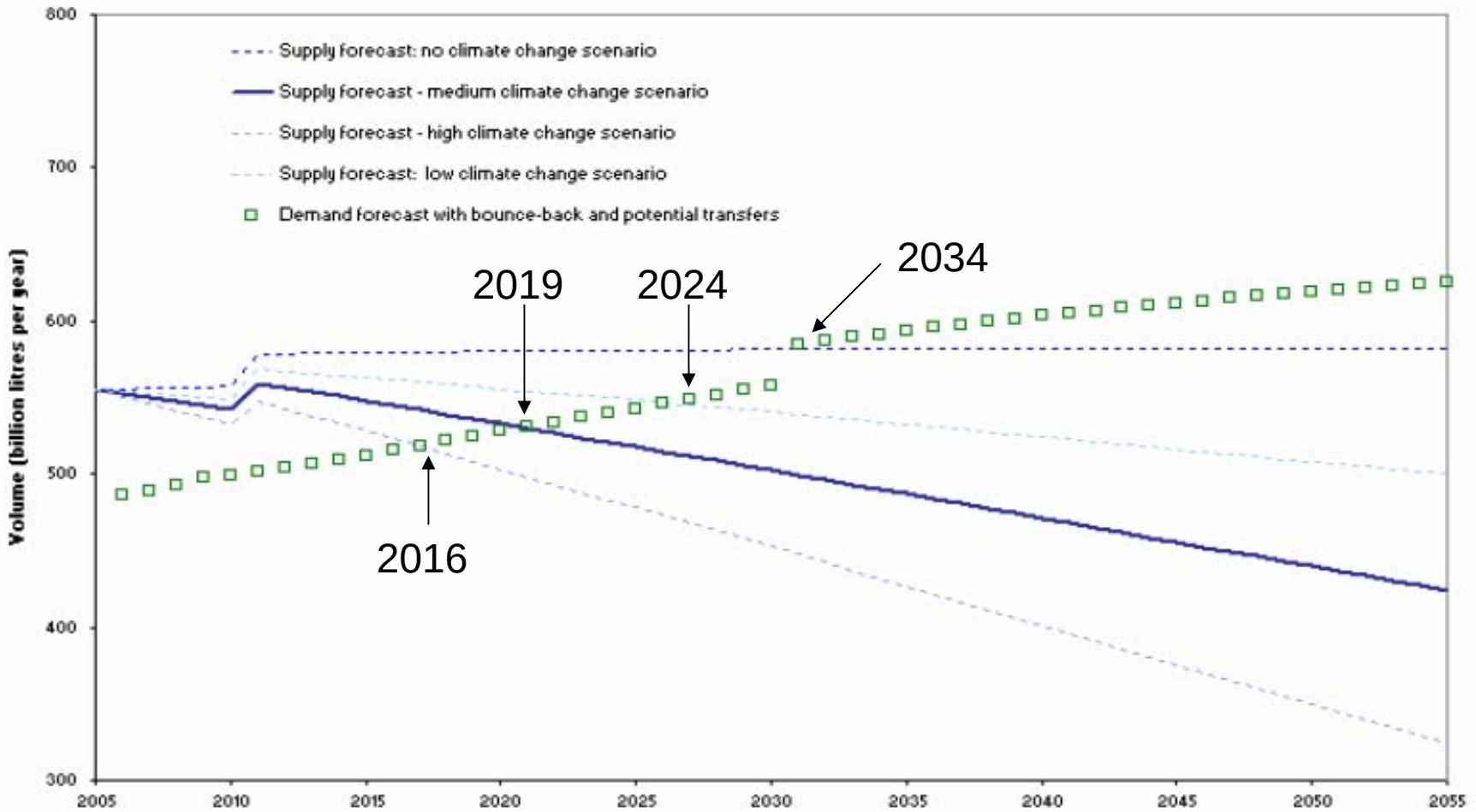
Source: http://www.metoffice.gov.uk/climatechange/science/monitoring/indicators.html

The environmental impacts of housing construction and use



Source: Furevik, T (2005)

Projected water yields for Melbourne



Source: Watersmart (2006), Draft Supply Demand Strategy for Melbourne 2006-2055

The environmental impacts of construction and use

- Depletion of natural resources
  - Biodiversity loss
- Soil loss and degradation
  - Pollution of land, air and water

Source: www.oren.org.au

Embodied Energy of Materials

Materials	MJ/kg	Materials	MJ/kg
Particle board	6	HDPE	75
Polypropylene (recycled)	8	Polypropylene	77
MDF	15	EPS	80
Steel (recycled)	16	LDPE	82
Aluminium (recycled)	17	PA	96
Glass	25	ABS (Acrylonitrile butadiene styrene)	107
Lead	34	HIPS (high impact polystyrene)	117
Brass	39	Stainless steel	128
Steel	58	PC (polycarbonate)	133
Copper	59	Aluminium	213
Zinc (diecast)	65	Nickel	383

Source: RMIT Centre for Design

What's driving sustainable construction?

- Market demand (*1)
- Improved risk management (*2)
  - Meeting and staying ahead of regulations (*3)
  - Future proofing (*4)
  - Healthier workplace environments (*5)
- New markets through reputation (*6)

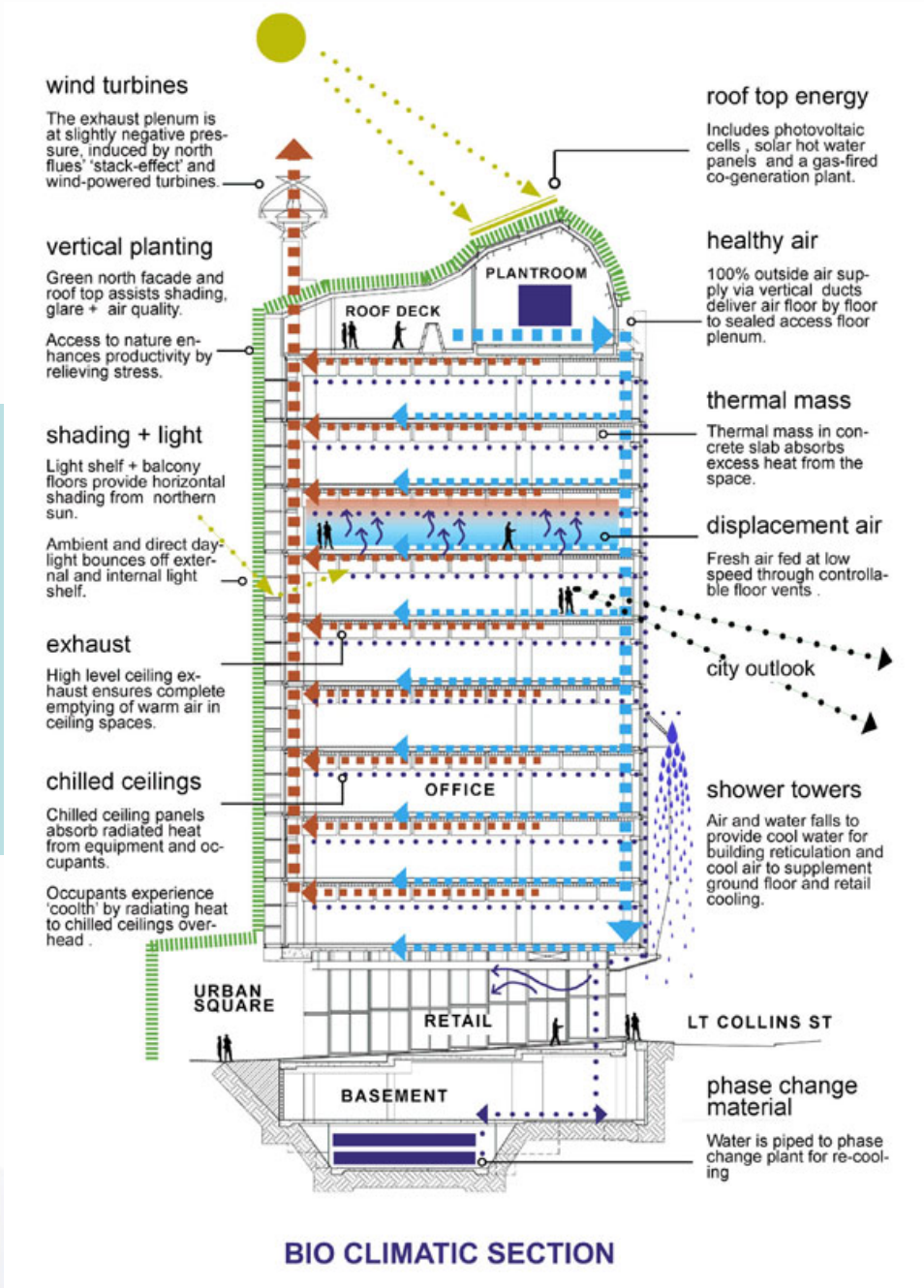
A recent NSW survey found that "on the whole, people are prepared to contribute financially to fixing environmental problems" (DEC, 2003)

What's in it for my customers?

- Lower bills (*1)
- Longer lasting, more durable buildings – less need for refits
- Healthier, more comfortable living and work environment (*2)
- Potential for improved investment return (*3)
- Personal satisfaction
  - making a difference
  - Marketing/Prestige (*4)
- SV Video

NAB Building Docklands

Principles of Sustainable Construction



BIO CLIMATIC SECTION

Energy and greenhouse

- Reduce energy use
  - First, use energy efficient design to suit your climate
- Reduce greenhouse emissions
  - Install energy efficient systems that use renewable or low-greenhouse sources

Reduce energy demand with good design

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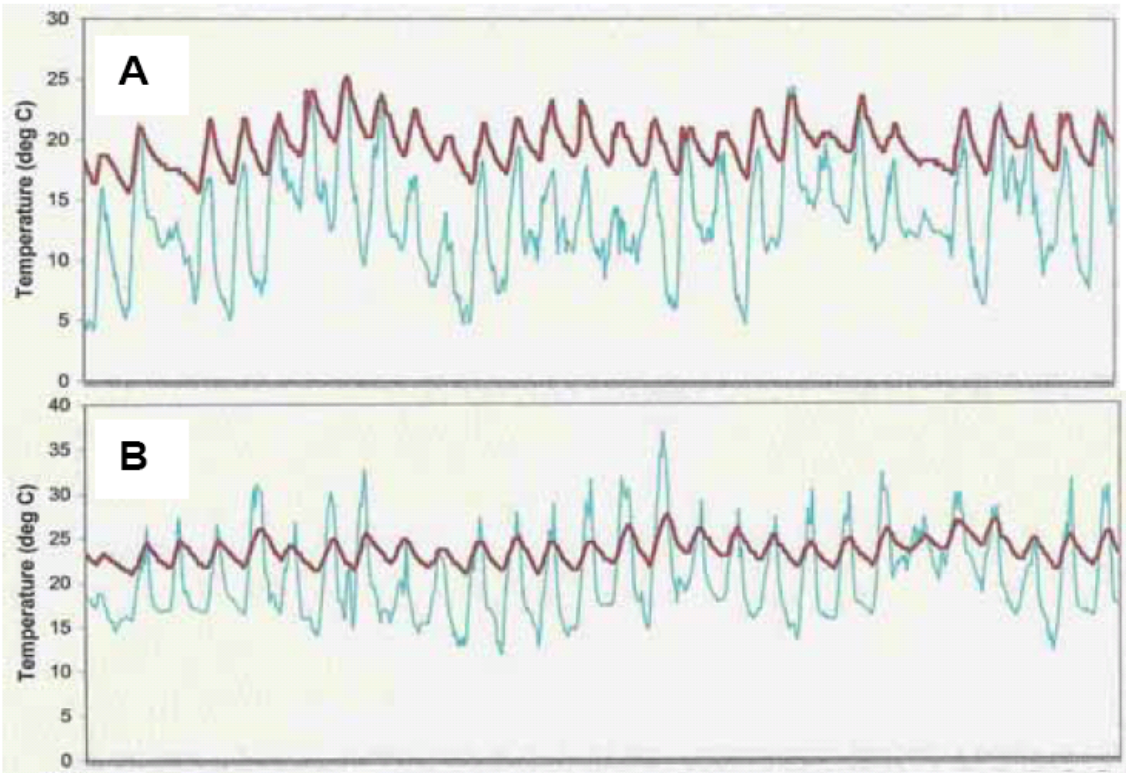
Daily ambient (blue) and indoor (dark red) temperature fluctuations for "The Heij-Shed" over two representative one-month periods in winter and summer respectively



Living Room

Winter 05

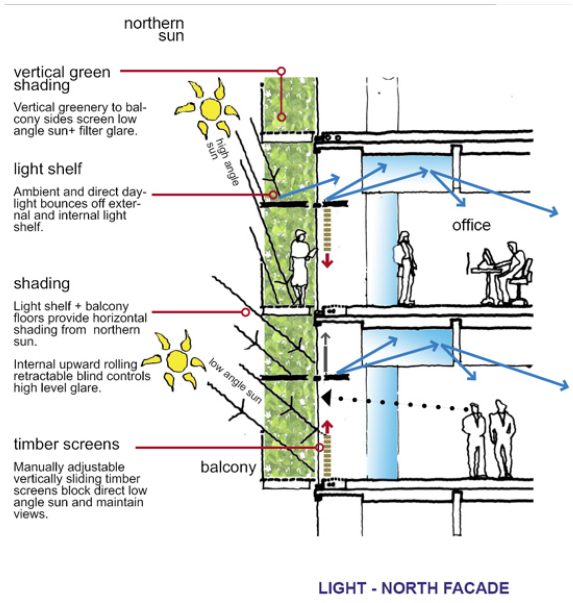
Living Room

Summer 06

Ref: CSIRO Sustainability Network (2006), Update No. 58E.

Reduce energy demand with good design

- Recycled timber louvres shade the west facade. Energy from photovoltaic panels on the roof powers the louvres, which move according to the position of the sun.



- The vertical gardens assist with shading, glare and air quality.
- The plants are grown from special planter boxes built into the balconies on every storey. Vines grow up the façade via stainless steel mesh.

- CH2 Video 1

CH2 Building, with permission City of Melbourne

Materials and waste

- Reduce materials use
  - Minimise use of new materials
  - Build to last (durability)
    - Refits (*1)
- Reduce waste to landfill
  - Avoid – reuse – recycle waste
- Reduce environmental impact
  - Choose materials with low environmental impact (*2)

Tender/developer Requirements

Federal Government

- All office space greater than 2000m^2 to be 4.5 star ABGR rated.

State Government

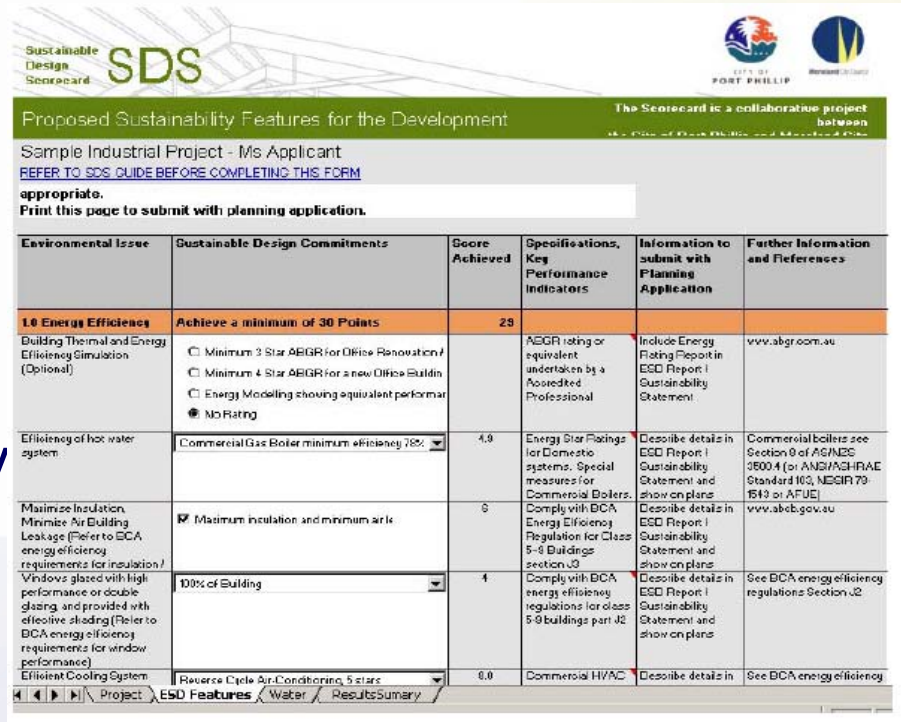
- **VICTORIA**
- The ‘Office Accommodation Guidelines 2005’ principles include:
  - 4 Star Green Star – Office Design Certified Rating is required for all new office buildings and 4 Star Green Star – Office Interiors Certified Rating for all new fitouts
  - 4.5 star ABGR rating
  - Office environments should be “safe, sustainable, healthy and assist productivity.”

Tender/developer Requirements

- Local Governments
  - Most have ESD requirements that should be addressed (Cardinia)
    - Site management plan
    - Waste management plan
    - Environmental management plan
  - Steps (residential) and Sustainable Design Scorecard (non-residential)
    - Moreland, Port Philip
- Developers
  - Vicurban
    - Docklands

Sustainability Scorecards

- Based on points scoring systems
- Awarded for various design or appliance features
- Minimum score required
  - Energy efficiency
  - Transport
  - Water
  - Waste
  - Materials
  - Indoor environment quality



Sustainable Design Scorecard SDS

Proposed Sustainability Features for the Development

The Scorecard is a collaborative project between

Sample Industrial Project - Ms Applicant

REFER TO SDS GUIDE BEFORE COMPLETING THIS FORM

appropriate.

Print this page to submit with planning application.

Environmental Issue	Sustainable Design Commitments	Score Achieved	Specifications, Key Performance Indicators	Information to submit with Planning Application	Further Information and References
1.0 Energy Efficiency	Achieve a minimum of 30 Points	29			
Building Thermal and Energy Efficiency Simulation (Optional)	○ Minimum 3 Star ABGR for Office Renovation / ○ Minimum 4 Star ABGR for a new Office Buildin ○ Energy Modelling showing equivalent performar ◉ No Rating		ABGR rating or equivalent undertaken by a Accredited Professional	Include Energy Rating Report in ESD Report / Sustainability Statement	www.abgr.com.au
Efficiency of hot water system	Commercial Gas Boiler minimum efficiency 78%	4.9	Energy Star Ratings for Domestic systems. Special measures for Commercial Boilers.	Describe details in ESD Report / Sustainability Statement and show on plans	Commercial boilers see Section 8 of AS/NZS 3500.4 (or ANSI/ASHRAE Standard 103, NBSIR 79-1543 or AFUE)
Maximize Insulation, Minimize Air Building Leakage (Refer to BCA energy efficiency requirements for insulation /	☑ Maximum insulation and minimum air le	6	Comply with BCA Energy Efficiency Regulation for Class 5-9 Buildings section J3	Describe details in ESD Report / Sustainability Statement and show on plans	www.abcb.gov.au
Windows glazed with high performance or double glazing, and provided with effective shading (Refer to BCA energy efficiency requirements for window performance)	100% of Building	4	Comply with BCA energy efficiency regulations for class 5-9 buildings part J2	Describe details in ESD Report / Sustainability Statement and show on plans	See BCA energy efficiency regulations Section J2
Efficient Cooling System	Reverse Cycle Air-Conditioning, 5 stars	8.0	Commercial HVAC	Describe details in	See BCA energy efficiency

Project | ESD Features | Water | ResultsSumary

Sustainability Scorecards

- SDS
  - (sustainable design scorecard)
- Green Star
  - Certification process
  - example
- Vicurban

40 Albert Rd Sth Melbourne, 6 star office design. Source GBCA

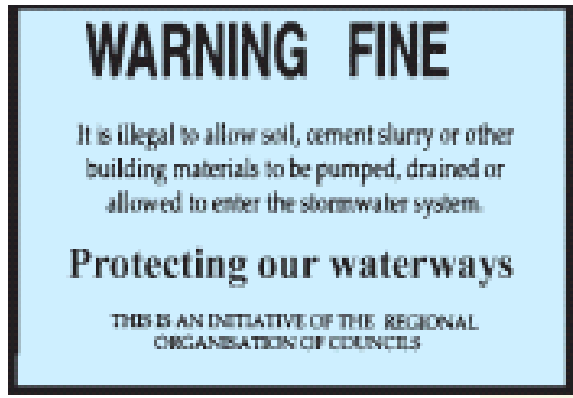
Brindabella Circuit, ACT, 5 star office design

Site Management

Legal requirements

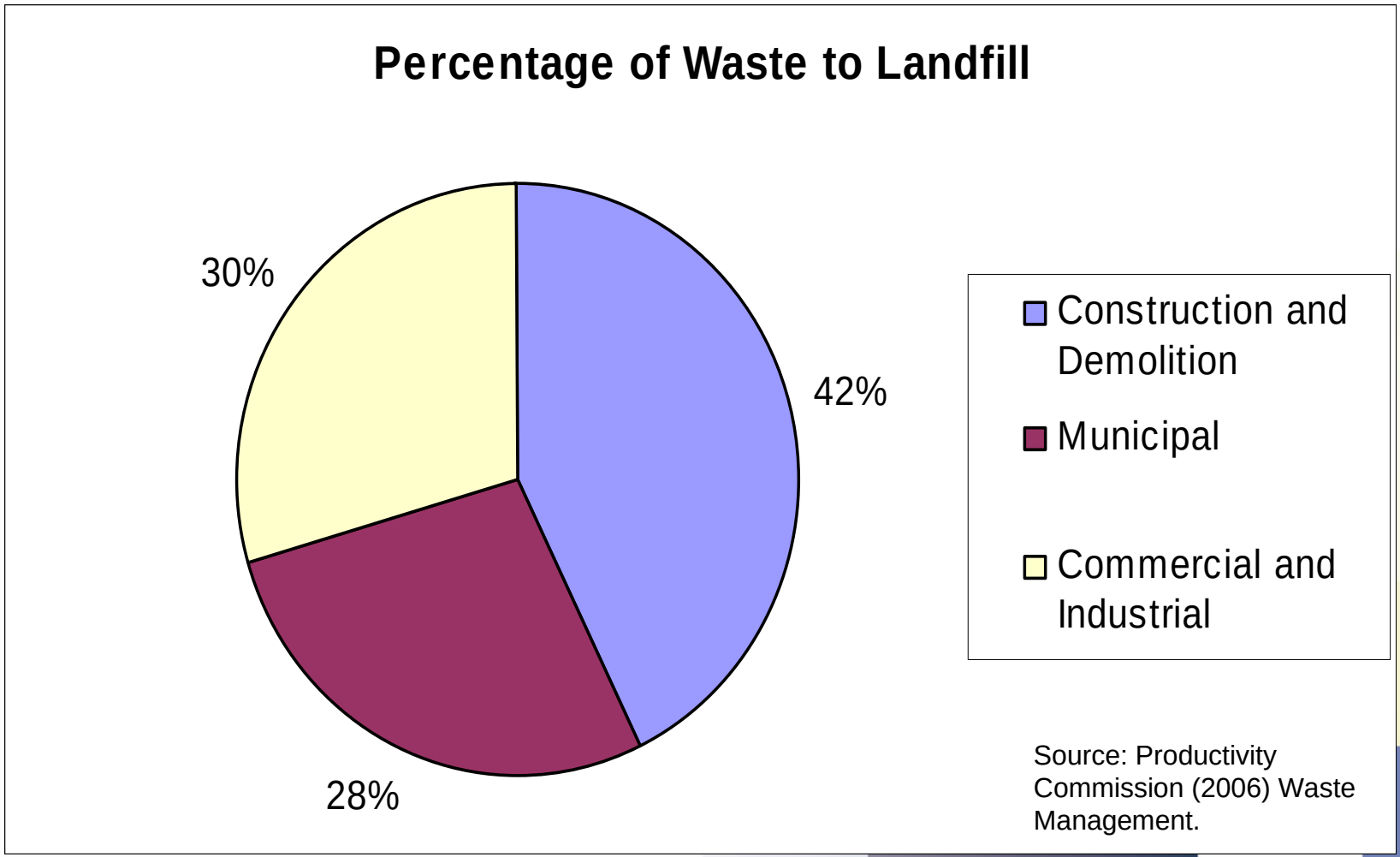
State and Local Government Laws

- Environment Protection Act 1970
  - Fines $5000+
  - Includes litter (*1)



- Local Government
  - an offence for sand, soil, screenings, chemicals and litter to leave your building site
  - Fines $250-$1000

Waste to landfill



Source: Productivity Commission (2006) Waste Management.

Soil erosion & sedimentation of waterways

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Pollution of waterways

- Litter, paints and solvents

Management Strategies

Waste Management

- Design to standard sizes
- Order only what you need
- Use prefabricated products
- Reuse what you can on site
- Sort on site wherever possible
- Use a recycler that accepts mixed waste

Wasted Resources

It is estimated that 10% of all paint produced is wasted. This equates to……

- 3,600 t of synthetic rutile
- 1,000 t of Chlorine
- 1,200 t of petroleum coke
- 2,500 t of Oxygen
- 3,500 t of Nitrogen
- 600 t of Carbon
- 600 t of Lime
- 200 GJ of energy
- 100 ML of water
- 300,000 t of rock, sand & clay moved

Or put another way:

- Drinking water sufficient for 3,000 people
- Energy for 2500 homes

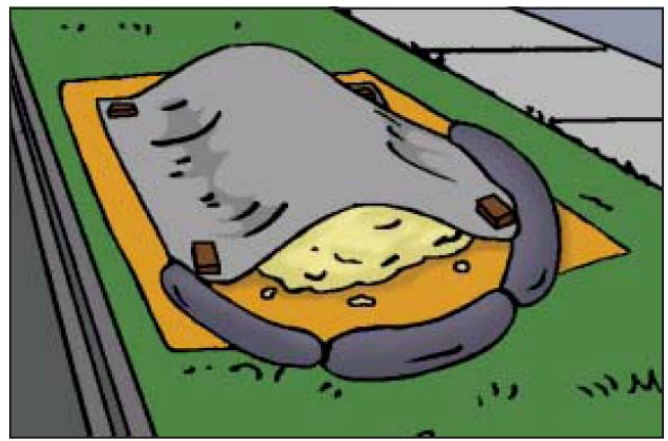
Erosion & sediment control

- Stop erosion and contain sediment on site
  - Disturb as little of the vegetation and surface as possible (*1)
  - Early downpipe connection (*2)
  - Sediment control fencing
  - Larger sites may require sediment pond

Erosion & sediment control

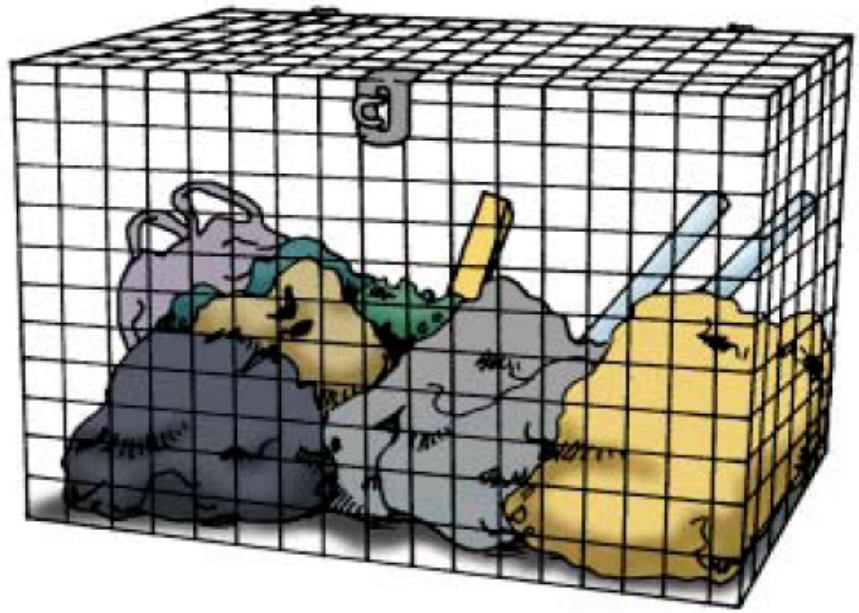
- Protect stockpiles
  - Place a tarp, plastic or bunded pallet under the area where the stockpile will be placed.
  - Place a secured covering over the stockpile.
  - Then place sediment control logs around the downslope base of the stockpile.

- Keep mud off road and onsite



Pollution of Waterways

- Keep litter contained on site
- Use a bin with a lid
- Make sure people use it



Pollution of Waterways

- Clean all equipment on site. Make sure the wash water stays on site.
  - Provide a wash up area.
- Collect water from concrete mixers for disposal onsite

Pollution of Waterways

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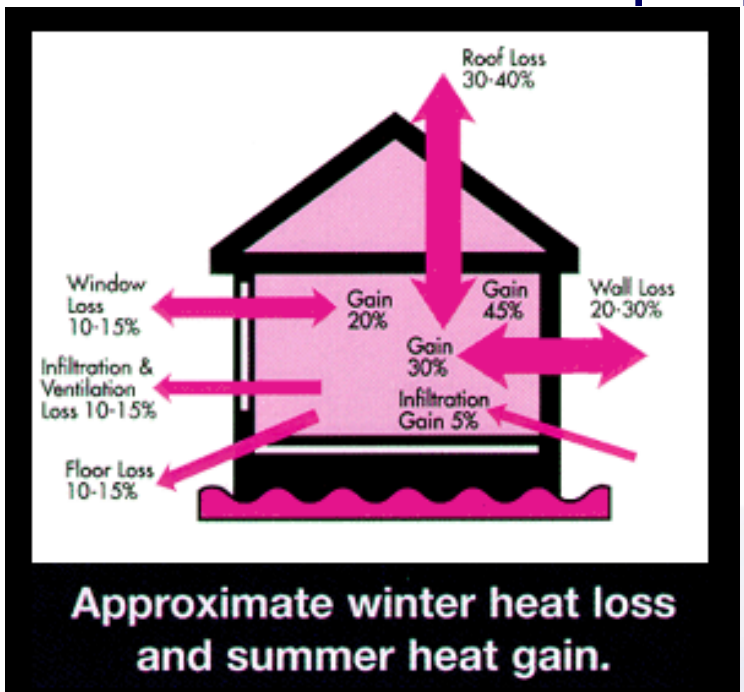
- Hazardous material
  - Fuels, solvents,
  - Stored in bunded areas or storage cabinet
- Spill kits

Building Envelope

Insulation

- Operational energy use

  - Insulate to the right level for your climate
  - Ensure insulation is properly installed



Approximate winter heat loss and summer heat gain.

Insulation types - overview

- **Choose an appropriate insulation type, or combination of types, for the application:**
  - Bulk
  - Reflective
  - Composite
- **Where possible, choose products that:**
  - are from natural, renewable sources
  - have recycled content
  - have no negative health impacts

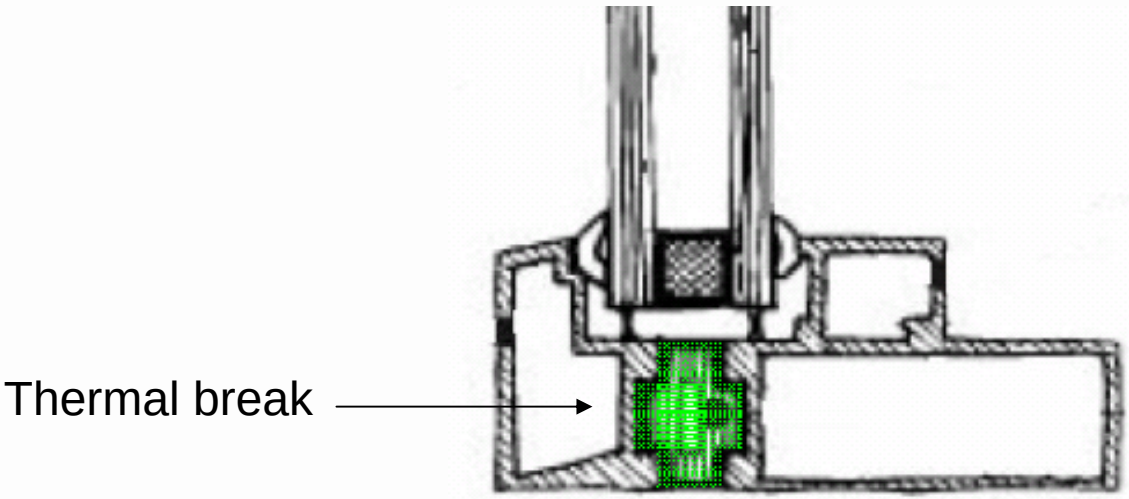
Glazing - big issues - action areas

- Operational energy use
  - glazing is generally the path of least resistance for heat loss and gain

- Reduce heat loss
- Reduce heat gain
- Encourage (controllable) natural ventilation

Glazing - reduce heat loss

- Use a moderate amount of glazing (esp. skylights)
- Double glaze all skylights
- Ensure windows can be well sealed
- If using aluminium frames, ensure they are insulated or have a thermal break

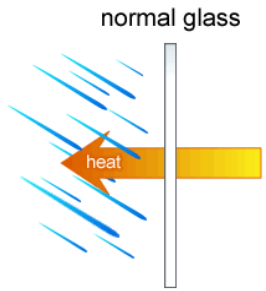


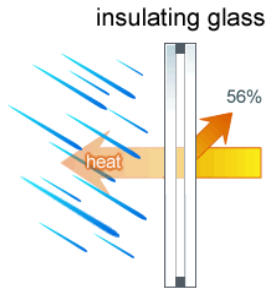
Source: Irwin Consultation

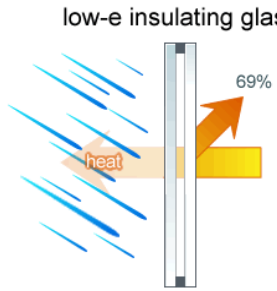
Glazing - reduce heat loss

- Double glazing windows and doors
  - Cool climates or climates with a high day-night temperature range
  - In milder climates, you may choose to focus on larger glazing assemblies only

Replacing single glazing with double glazing reduces heat loss by 30-45%





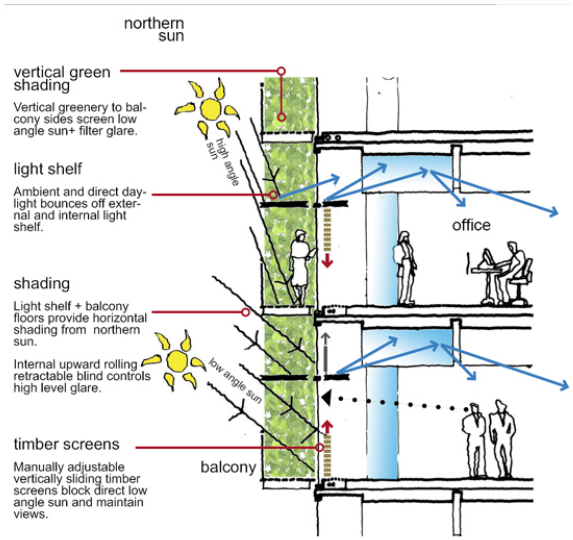


Glazing - reduce heat gain

- Use a moderate amount of glazing (esp. skylights)
- Shade north facing glazing with external shading
- Shade east and west facing glazing with external shading capable of shading the whole area
- Shade all skylights (inbuilt shading available) and use low-e glazing

Glazing - reduce heat gain

- Recycled timber louvres shade the west facade. Energy from photovoltaic panels on the roof powers the louvres, which move according to the position of the sun.



LIGHT - NORTH FACADE

- The vertical gardens assist with shading, glare and air quality.
- The plants are grown from special planter boxes built into the balconies on every storey. Vines grow up the façade via stainless steel mesh.

CH2 Building, with permission City of Melbourne

Glazing - encourage ventilation

- Use windows with a large openable area that open wide (ensure they can be well sealed when required)
- Ensure unobstructed air paths between openings on opposite sides of the building
- Take security and noise issues into account

Water management and landscape

Water - big issues - focus areas

- Water quantity (using water)
  - Growing populations
  - Increasing need for environmental flows

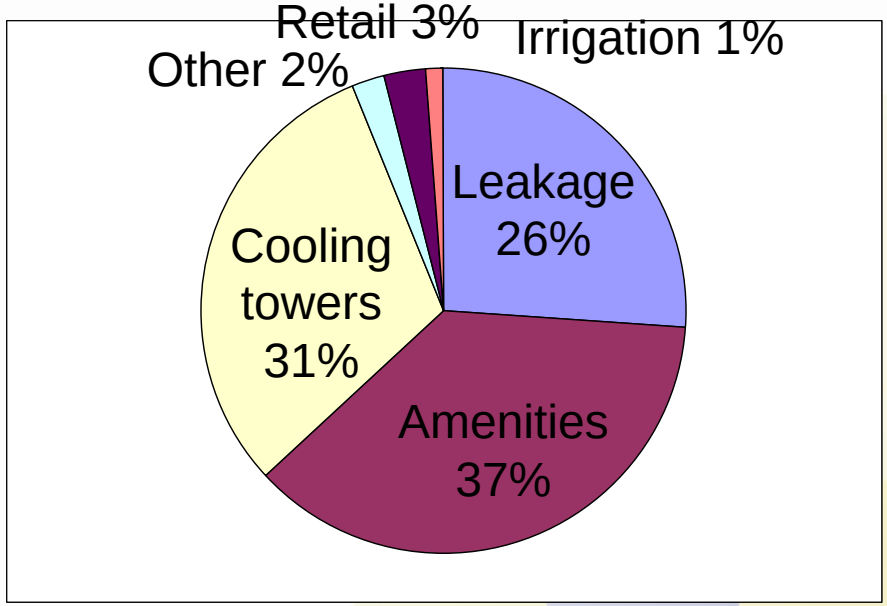
  Looming gaps between demand and supply

- Water quality (managing stormwater)
  - Declining or stable: needs to improve
  - Precious nutrients being lost

First Reduce

Identify major water users

- Depends on class of building
- Typical uses
  - toilets
  - showers
  - washing
  - irrigation



Then develop strategies to reduce

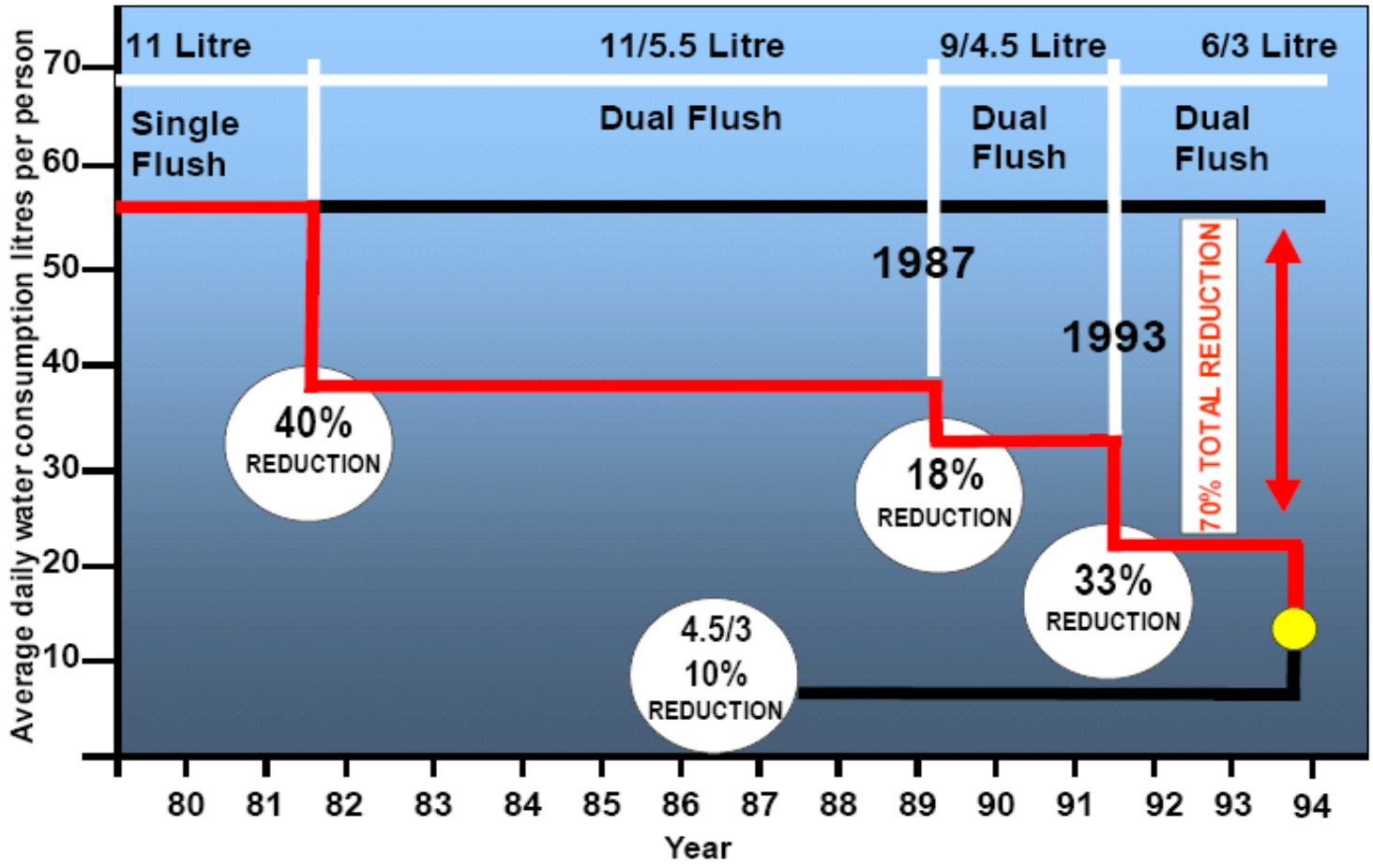
Low flow showers

Builders' opportunities

- Water use is a combination of
  1. fixture or appliance
  2. the way it is used
- Builders can control and influence the fixture more than the way it's used

Install efficient indoor fixtures and appliances

Example toilets



*Water consumption is based on a use ratio of 1 to 4 solid/liquid use

Source: Department of Heritage 2006

Design

- Heating, ventilation and air conditioning
  - Determine site water collection and reuse options.
  - Determine waste water treatment options.
  - Specify use of water wise landscaping.
- Amenities (*1)
  - Specify minimum 4 star WELS rated fittings.
  - Consider waterless urinals.
- Leakage
  - Design to include sub-metering of tenancies, plant and landscape uses.

Source: Department of Heritage and Environment (2006),

Construction

- Consider setting goals for potable and non-potable water use on site.

- Fitout and commissioning
  - Heating, ventilation and air conditioning
    - Ensure that water saving and water treatment technologies are installed and commissioned as designed.
  - Amenities
    - Ensure that WELS ratings are specified for water using fittings and appliances installed in any fitout.
  - Leakage
    - Ensure sub-metering of tenancies occurs and is supported by appropriate leak detection and reporting signage.

Refurbishment

- Heating, ventilation and air conditioning (*1)
  - Cooling towers
- Amenities
  - Specify higher WELS rated appliances and fittings.
  - Upgrade toilets and urinals to newest efficiencies.
- Leakages (*2)
  - Benchmark base flows and identify leaks.
  - Identify any overpressure problems
  - Improve sub-metering

Sources to reuse and recycle

- Rainwater
  - Collected off roofs
- Stormwater
  - Collected from other impervious surfaces e.g. roads, driveways
- Wastewater
  - Greywater: from shower, laundry, basins,
  - Blackwater: from toilet

Reuse water

- Reuse = capture, **no treatment**, use

<u>Reuse examples</u>:

- From rainwater to toilet flushing or garden or laundry
- From shower or laundry (greywater) to outdoor (subsurface irrigation) - has problems though…

Regulations

- Must involve a licensed plumber
- Diversion only
  - no council permit in sewered areas, check in unsewered.
  - Should consult council and local water authority
- Treatment system
  - EPA approval and council permit.

Landscape - Big issues

- Reduce outdoor water use
- Stormwater runoff leads to contamination of waterways

- Use planting with low water needs
- Use efficient irrigation systems
- Maximise pervious surfaces
- Minimise pollutants to waterways

We've already covered the use less water point!
Following are some other considerations.

Reduce runoff

- Reduce volume and reduce rate of runoff
  - Volume: closer to natural flows
  - Rate: reduces flooding potential
- Reduce volume - maximise pervious surfaces
  - Choose low water use plantings over paving
  - Choose permeable paving over impermeable
- Reduce rate - minimise pipe connectivity
  - Use OSD where necessary
  - Integrate landscape with effective stormwater management e.g. swales, trenches, detention ponds etc

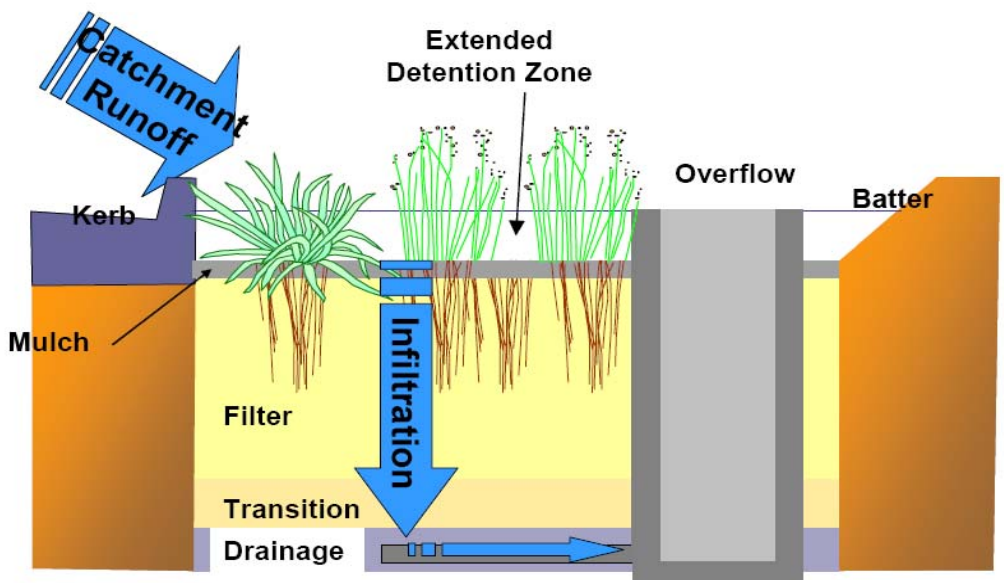
Source: www.tececo.com

Water Sensitive Urban Design (WSUD)

- The use of water efficient appliances and rainwater, stormwater, wastewater, groundwater and greywater reuse as alternative sources of water to conserve potable supplies;
- Detention, rather than rapid conveyance, of stormwater;
- Reuse, storage and infiltration of stormwater, instead of drainage system augmentation;
- Use of vegetation for stormwater filtering purposes;

Water Sensitive Urban Design (WSUD)

- Water-efficient landscaping to reduce potable water consumption;
- Localised wastewater treatment and reuse systems to reduce potable water consumption and
- Minimise environmentally harmful wastewater discharges;



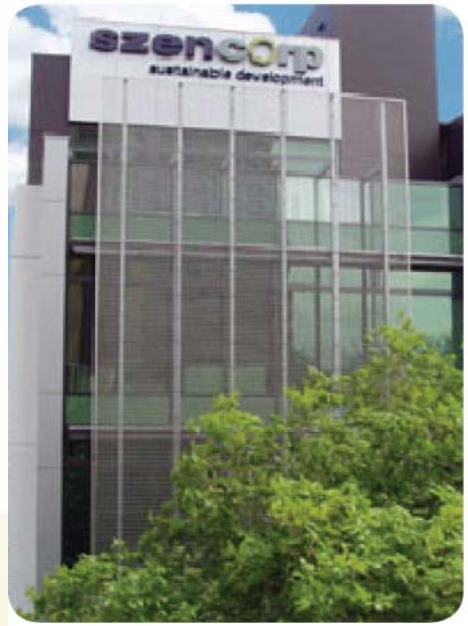
Source: Land and Water Constructions (2007)

Case Studies - CH_2 Building

- City of Melbourne Building
  - Opened August 2006
  - Blackwater Treatment.
  - About 100,000 litres of water a day will be extracted from the sewer in Little Collins Street. (*1)
  - Treated to create A-grade clean water suitable for all non-drinking uses.
  - Will provide water for CH2's water cooling, plant watering and toilet flushing needs.
  - Also other council buildings, city fountains and plants.
  - More water will be saved through recycling water from the fire-safety sprinkler system and from rainwater.

Case Studies – Szencorp Building

- 40 Albert Rd Sth Melbourne
- 6 star Green Star office design - refurbishment
- Low flow shower heads and taps
- Dual flush toilets – 4.53 L/flush
- Waterless urinals
- Greywater used to flush toilets
- Rainwater for toilet flushing
- Water use 82% less than old design
- Sewer discharge 72% less



Source: Department of Heritage and Environment (2006),

Case Studies – IBM Building

- West Pennant Hills, Sydney
- Retrofit of existing building with data centre (*1)
- Identified leaks in ornamental ponds
- Replaced timed flushing urinals with sensor activated
- Capitol cost $27800, annual saving $82500
- Saves 160 kilolitres/day
- Water use reduced by 60% in 2 years

Energy Management

www.greengeek.ca/2006/08/20/smart-lighting-as-a-solution-to-light-pollution/

Big issues - focus areas

- Energy use
  - Growing populations
  - More air conditioners
  - Looming gaps between peak electricity demand and supply

- Greenhouse gases
  - Climate change and global warming
  - Droughts and extreme weather

Recap: principles

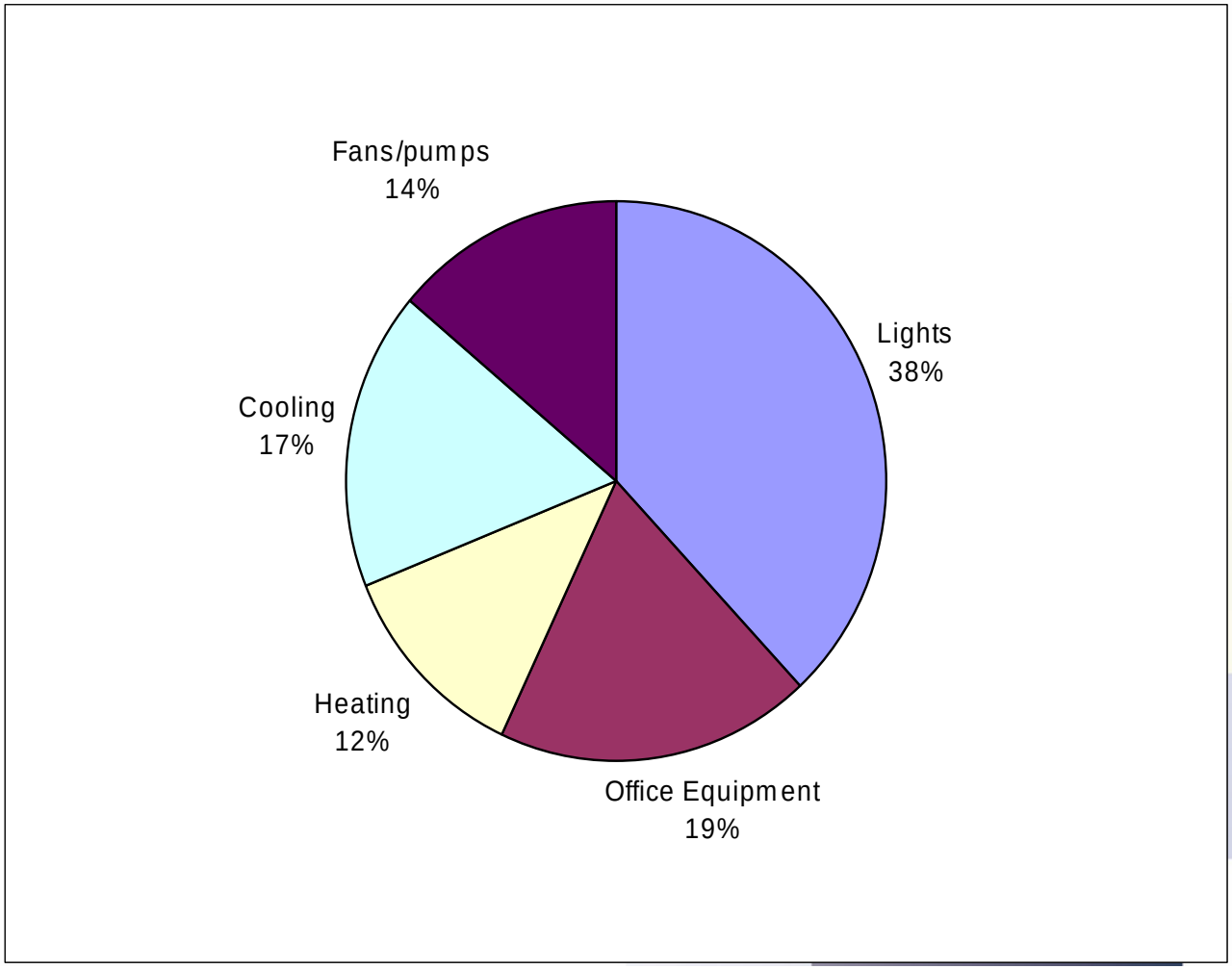
Reduce energy use first:

- ✓ eliminate wastage
- ✓ use efficient systems

Then choose low greenhouse sources:

- ✓ gas
- ✓ renewables

Typical Office Energy Consumption



Source: http://www.greenhouse.gov.au/lgmodules/wep/buildings/training/training4.html

Reduce greenhouse gases

Your greenhouse emissions depend on:

- The **amount** of energy you use
- The **source** of the energy

	Renewable	Natural gas*	Coal fired electricity**
kg CO_2 emitted per kWh of heat energy used in the home	**0** 	**0.33** 	**1** 

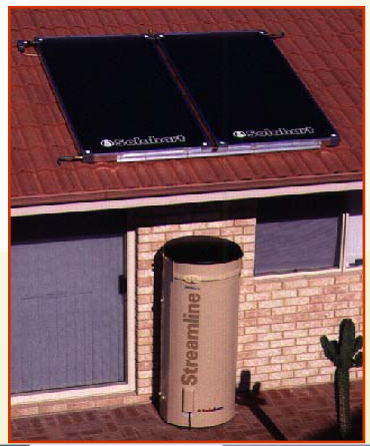
* Assumes appliance efficiency of 70%. LPG is approximately 0.4

** For electricity generated in Victoria this figure is 1.4. In Tasmania it is virtually zero due to use of hydro. In the NT it is about 0.75 due to use of gas for generation.

Hot water systems

Hot water systems can use a wide range of heat sources:

- Electricity
- Gas – continuous or storage
- Solar – gas or electric boost
- Heat pumps
- Solid fuels



Reduce heating & cooling energy use

- First, is there anything you can do to minimise or avoid the need for heating and cooling systems?
  - energy efficient building design (*1)
  - Natural ventilation
  - Fans (*2)
- Air-conditioning energy savings come from a very wide range of areas
  - maintenance, and the configuration and commissioning of controls are often the most important.
  - Efficient boilers and chillers,
  - Reducing waste in the way that hot and chilled water supplies are used (*3)

Reduce lighting energy use

- Reduce power density
  - the amount of electricity used for lights per metre squared
- Reduce hours of use (*1)
- Design lighting layouts efficiently for purpose (*2)
- Use energy efficient fluorescent lighting
- Use high frequency electronic ballasts (*3)




Reduce lighting energy use

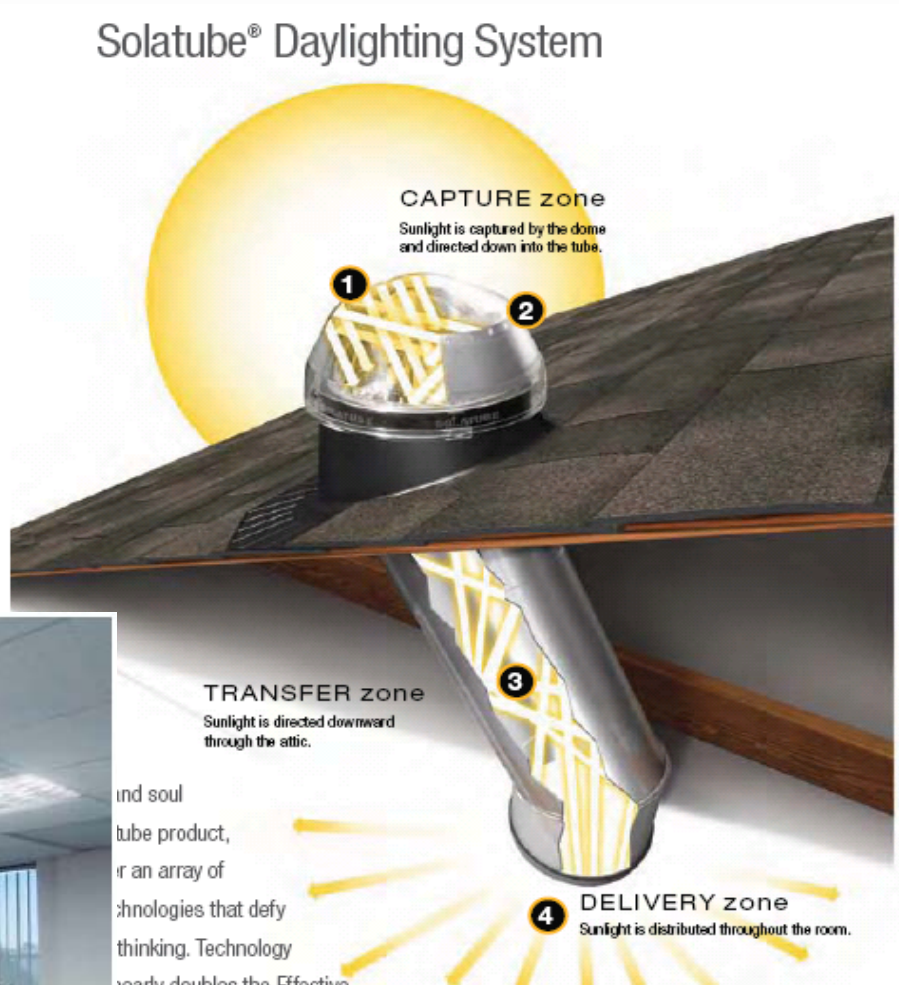
	18W CFL	100W Incandescent	2 x 50W halogens	2 x 11W CFL downlights
Lifetime (hours)	10,000	1,000	2,000	10,000
Purchase cost	$3	$0.50	$15*	$48
Purchase cost over 10,000hrs	$3 (1 lamp)	$5 (10 lamps @ 50c)	$12 (8 lamps @ $1.50)	$48 (1 lamp)
Running cost over 10,000 hrs	$30.60	$170	$204*	$37.40
Total cost	**$33.60**	**$175**	**$216**	**$85.40**
CO2 produced	**180 kg**	**1,000 kg**	**1,200 kg**	**220 kg**

* includes transformer

Energy saving lights

Increase natural light

- Benefits



Source: www.solatube.com.au

Photovoltaic systems

- Grid connected is preferable to stand alone
- Use efficient electrical appliances and lighting to maximise energy returned to the grid
- Building integrated systems can replace other building materials to offset costs

Photo of MCG photovoltaics

Photovoltaic systems

- Provide adequate north facing roof area at the right pitch for photovoltaic panels to be installed
- Ensure roof area will not be overshadowed now or in the future
- Allow about 10m^2 per 1kWp of PV
- PV panels get hot and need good ventilation
- All renewable electricity systems must be designed and installed by a certified contractor

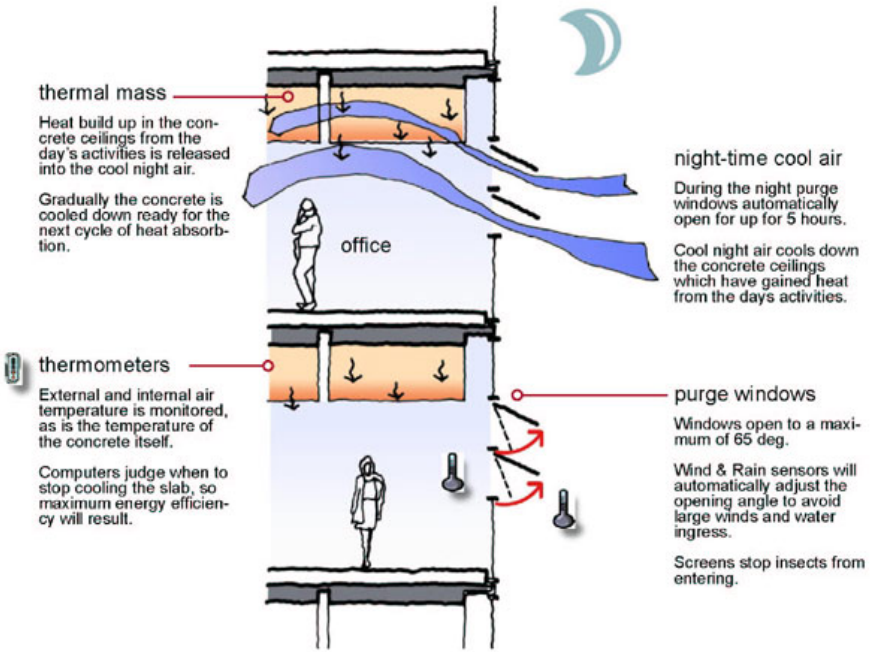
Recent changes to BCA for class 5-9 buildings – Energy Efficiency

- In effect from May 1st 2006
- Classes:
  - 5 (office),
  - 6 (retail),
  - 7 (carpark, warehouse),
  - 8 (factory),
  - 9 (clinic, day surgery, theatre, cinema, school, aged care building),

BCA changes

- Only deals with operational energy (*1)
- Raises performance requirements of heating cooling and lighting systems
- Covers
  - Building fabric
  - External glazing (*2)
  - Building sealing (*3)
  - Air conditioning and ventilation systems (*4)
  - Artificial lighting and power (*5)
  - Hot water supply
  - Access for maintenance

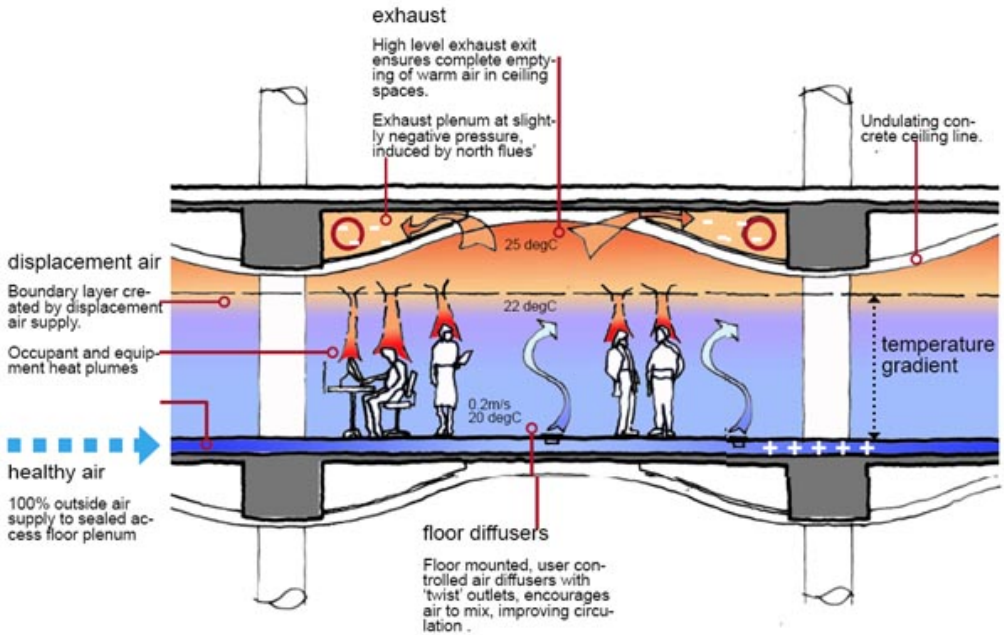
Case Study –CH_2



AIR FLOW - PURGE WINDOWS

- Thermal mass ceiling
- Night time purge

- High level heat exhaust
- Floor mounted diffusers



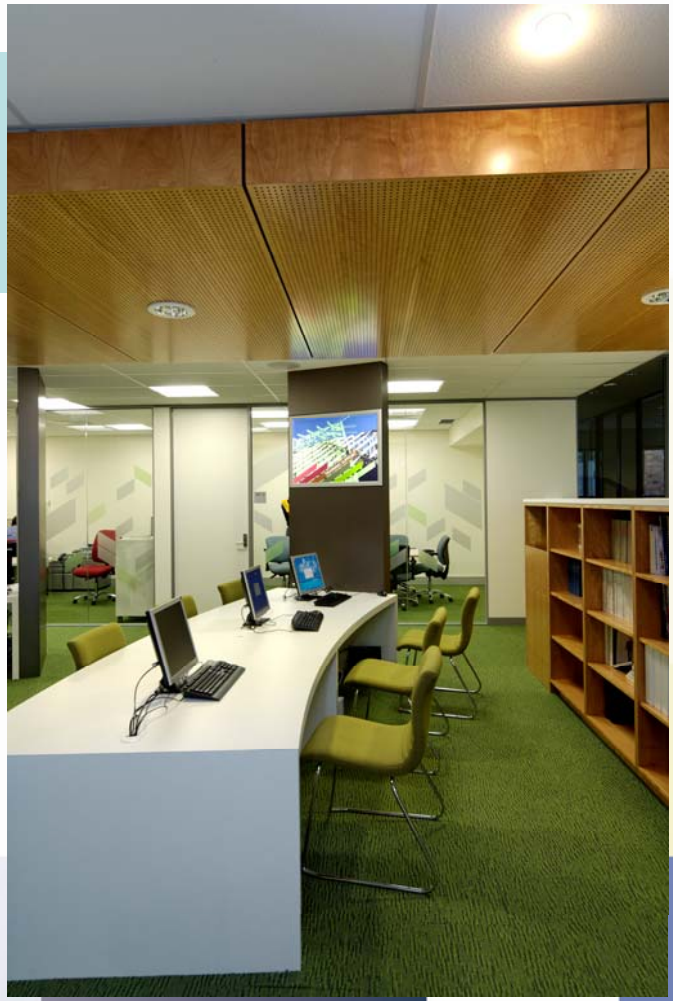
AIR FLOW - OFFICES

Case Study – Szencorp Building

- 5 Star ABGR + 20% reduction in carbon dioxide
- Ceramic fuel cell to generate low-emission, offgrid energy (*1)
- Two solar PV grids generating 5.5kW (*2)
- Increased ceiling height allowing use of thermal mass for improved energy efficiency.
- 70% reduction in energy use compared to conventional offices.
- Reduction in office lighting power density

Source: Department of Heritage and Environment (2006),

Fit Out



Big issues - focus areas

- Health impacts of materials
- Environmental impacts of materials
- Appliance energy and water use

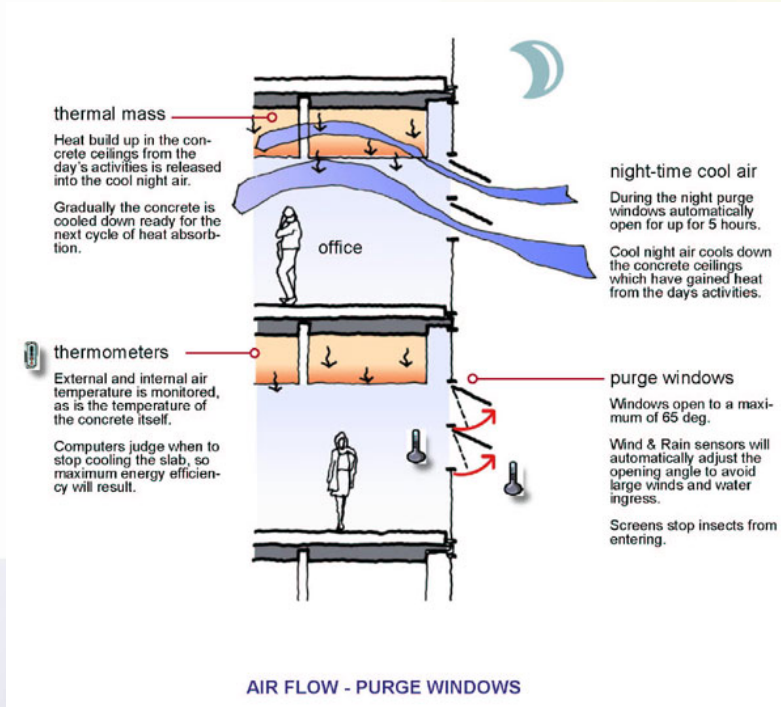
- Avoid materials that outgas pollutants
- Choose materials with low environmental impact
- Avoid timber from old growth forests and rainforests
- (if relevant) select energy and water efficient appliances

Health impacts: airborne pollutants

- Volatile organic compounds (VOCs) are airborne pollutants commonly found in:
  - paints and paint strippers
  - manufactured wood products and wood preservatives
  - adhesives
  - synthetic or treated textiles, vinyls
  - carpets and synthetic underlays
- Low emissions from large surface areas can result in high total emissions (e.g. carpets, paints)

Reduce health impacts

- Eliminate the causes of indoor air pollution
  - Use (at minimum) low VOC materials and finishes
  - Use (preferably) VOC free materials and finishes
- Ventilate indoor spaces
- Separate problem materials from occupants
- Absorb pollutants with indoor plants



AIR FLOW - PURGE WINDOWS

Reduce environmental impacts

- Reduce materials use
  - Avoid unnecessary finishes and linings
  - Dimension to standard sheet sizes where practicable
- Reuse materials where possible
- Use materials with recycled content
- Use materials with low environmental impact
  - Use databases like *EcoSpecifier* to help you

Joinery

- Use recycled, plantation or FSC certified timber
- Use fast cycling renewable timbers such as bamboo
- Use natural oils and waxes in preference to solvent-based or synthetic sealers
- Include a multi-bin waste sorter in kitchen joinery
  - Separate bins for containers, paper, organics and waste

Tips - Floor coverings

- Use natural, renewable low allergenic materials
  - e.g.. plantation timber, cork, marmoleum, sisal..
- Use materials that are reused or have recycled content
- Use durable, low maintenance materials
- If using carpet, install carpet tiles with recycled content
  - Ensure adhesives used are low VOC
  - Ask if the manufacturer has a take-back scheme
- Tile or polish concrete floors intended as thermal mass

Tips - Paints

- Leave surfaces unpainted where practicable
  - For example, avoid painting brickwork
- Outdoors:
  - Ensure paints and acrylic render systems are durable and non-toxic
- Indoors:
  - Use low VOC paints for walls and ceilings
  - Use pre-finished skirtings, balustrades etc where practicable
  - Also natural (non-petrochemical) paints available for indoors

Tips - General appliances

- Select appliances with a high energy AND water rating
  - no more than one star or A below best available
- Focus particularly on the big energy and water users
- CH2 – Video 2