BLOWING HOT AND COLD

How to retrofit and manage heating, ventilation and air conditioning systems in commercial buildings

Seminar 1: How Does HVAC Work, Ownership Requirements and Issues

Presenter - Bryon Price
Board Member - Australian Institute of Refrigeration Air Conditioning and Heating
Strategic Development Director - A.G. Coombs Group

AIRAH

CITY OF MELBOURNE

SEMINAR 1

HVAC 101 – HVAC Explained, Ownership Requirements and Issues

1. HVAC What it Does & How it Works

- Why it is important
- Explain its role in providing comfort and ventilation
- Thermal transfer and ventilation mechanisms
- Typical system components
- How HVAC uses energy and water
- How HVAC systems vary and the differences in different standards of buildings
- Why is maintenance important & risk issues
- How do I get to know my HVAC

2. Regulatory Issues

- Essential Safety Measures
- Building Regulations
- Safety
- CBD / NABERS
- Refrigerant Phase Out

3. Ownership Issues

- Performance
- Regulatory Compliance
- Maintenance and Change
- Energy and water
- Costs and Lifecycle

SEMINAR 2

HVAC 101 – HVAC Management and Improvement Opportunities

4. Management and Operation

- System performance, internal conditions, health and safety, energy and water, modifications, maintenance, tuning, engagement, metering, documentation and records
- Managers – Occupiers – Service providers / maintainers

5. Maintenance

- Essential safety measures
- Preventative vs reactive (breakdown)
- Energy and water implications

6. Lifecycle Opportunities

- Replacement
- Upgrades
- Retrofits

7. Improvement Planning & Delivery

- Objectives and outcomes
- Maintenance, Tuning and Operations
  - Engagement and Procurement
- Investment in Change
  - replacement/upgrade/retrofit
- Keeping the benefits

PART 1. HVAC What it Does & How it Works

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- Thermal transfer and ventilation mechanisms
- Typical system components
- How HVAC uses energy and water
- How HVAC systems vary and the differences in different standards of buildings
- Why maintenance is important & the risk issues
- How do I get to know my HVAC

1. HVAC What it Does & How it Works

HVAC – Why it is important

1. Tenant Services - Amenity
   - *Comfort, Reliability, Health, Safety*
2. Compliance
   - *Essential Services, Building Regulations*
3. Cost
   - *Energy, Water, Maintenance, Repair/Replace*
4. Asset
   - *Depreciation, Components - Limited Life*

HVAC – Why is it important

CITY OF MELBOURNE

A Quantitative Research Report on:

2014 HEATWAVE BUSINESS IMPACTS – SOCIAL RESEARCH

Ref No. 23910 • 24 March 2014

Sweeney Contacts:
Lewis Jones

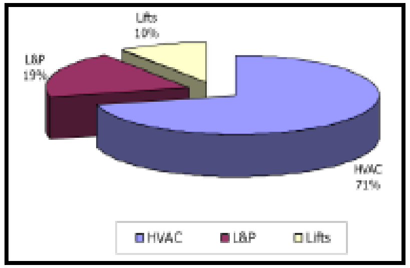
City of Melbourne Contact:
Beth McLachlan

The current study was developed to determine the **perceived impact** of the heatwave that occurred in Melbourne from 14 to 17 January 2014 on the **businesses** in the Melbourne municipality. The study is based on 601 telephone interviews with business owners or operators conducted approximately four to seven weeks after the January heatwave.

The majority of businesses report **perceived negative impacts** of the **four day heatwave** in terms of...

- The operational costs of air-conditioning and other cooling equipment (62%);
- The level of comfort for their workforce (59%); and
- The motivation and morale of their workforce (59%).

HVAC systems are responsible for:
- 50%± energy usage in buildings
- typically over 50% of potential improvement
- over 50% of risk to retaining energy efficiency, and
- over 50% of maximum demand / peak load



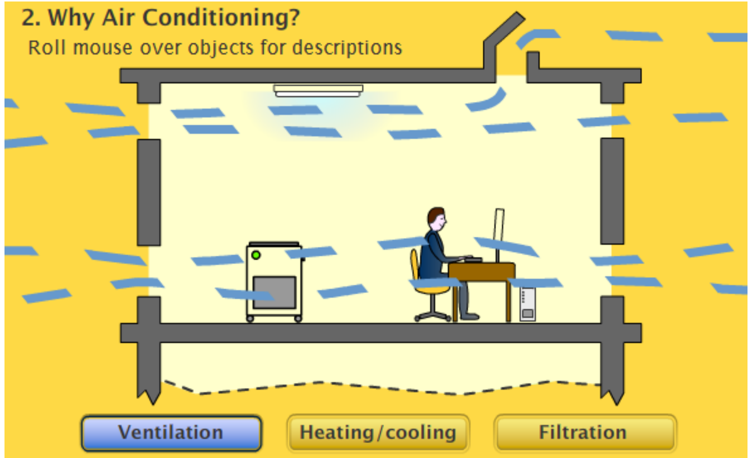
“can be up to around 25% of typical outgoings...”

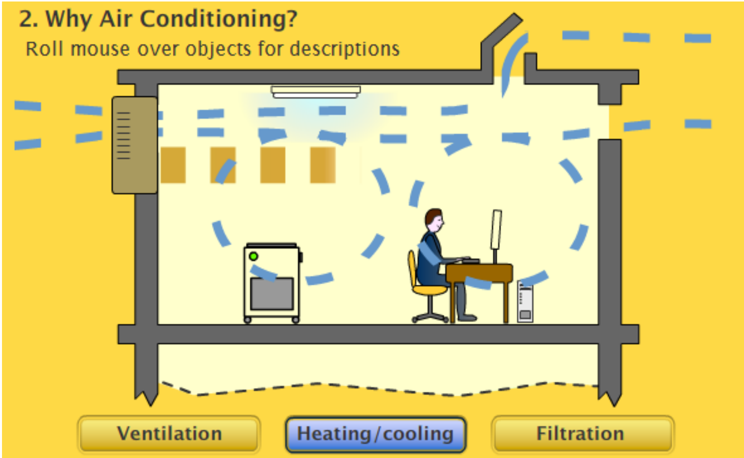
1. HVAC What it Does & How it Works

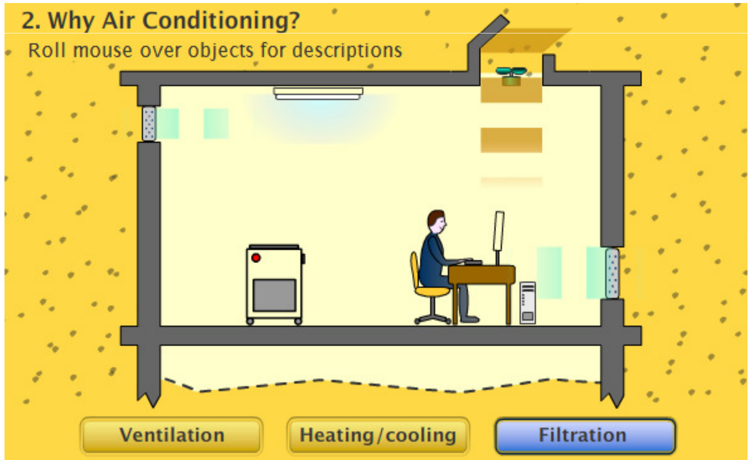
What it Does

1. Ventilation, Fire and Life Safety
2. Heating and Cooling
3. Indoor Environmental Quality IEQ

1. HVAC What it Does & How it Works



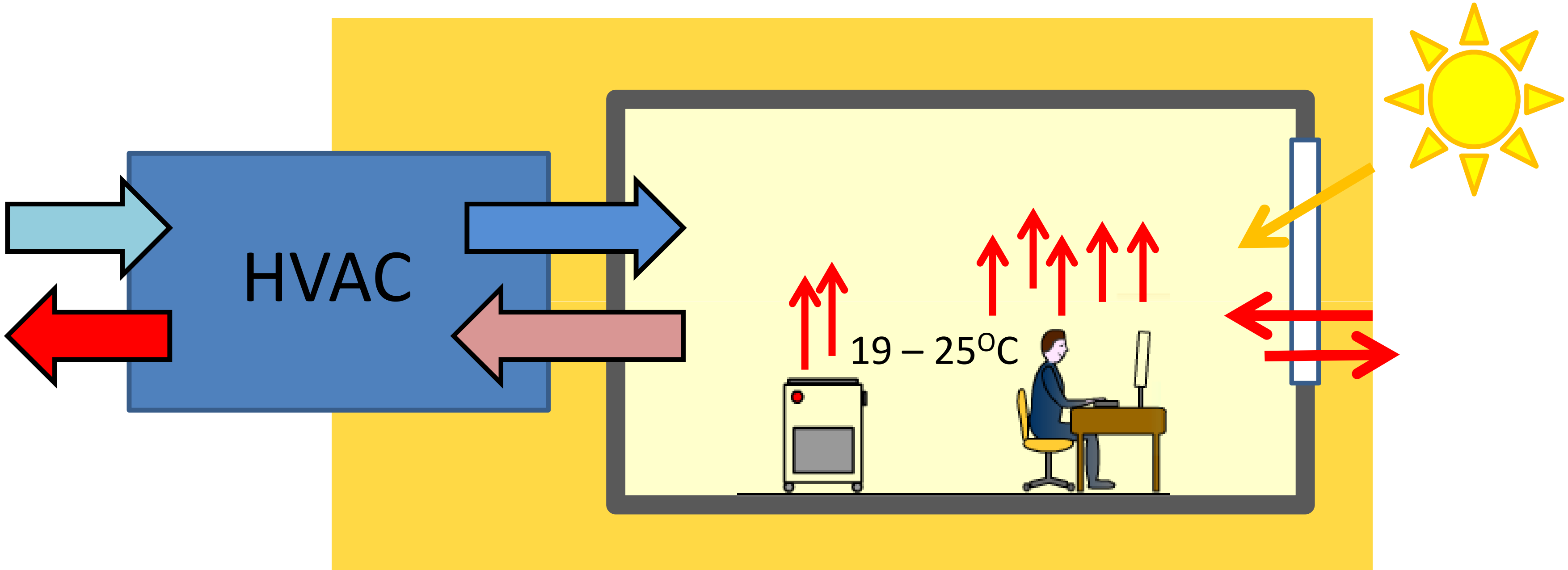




Source AIRAH Air Conditioning 101 Online Course

- Ventilation, Fire and Life Safety
- Heating and Cooling
- Indoor Environmental Quality IEQ

1. HVAC What it Does & How it Works

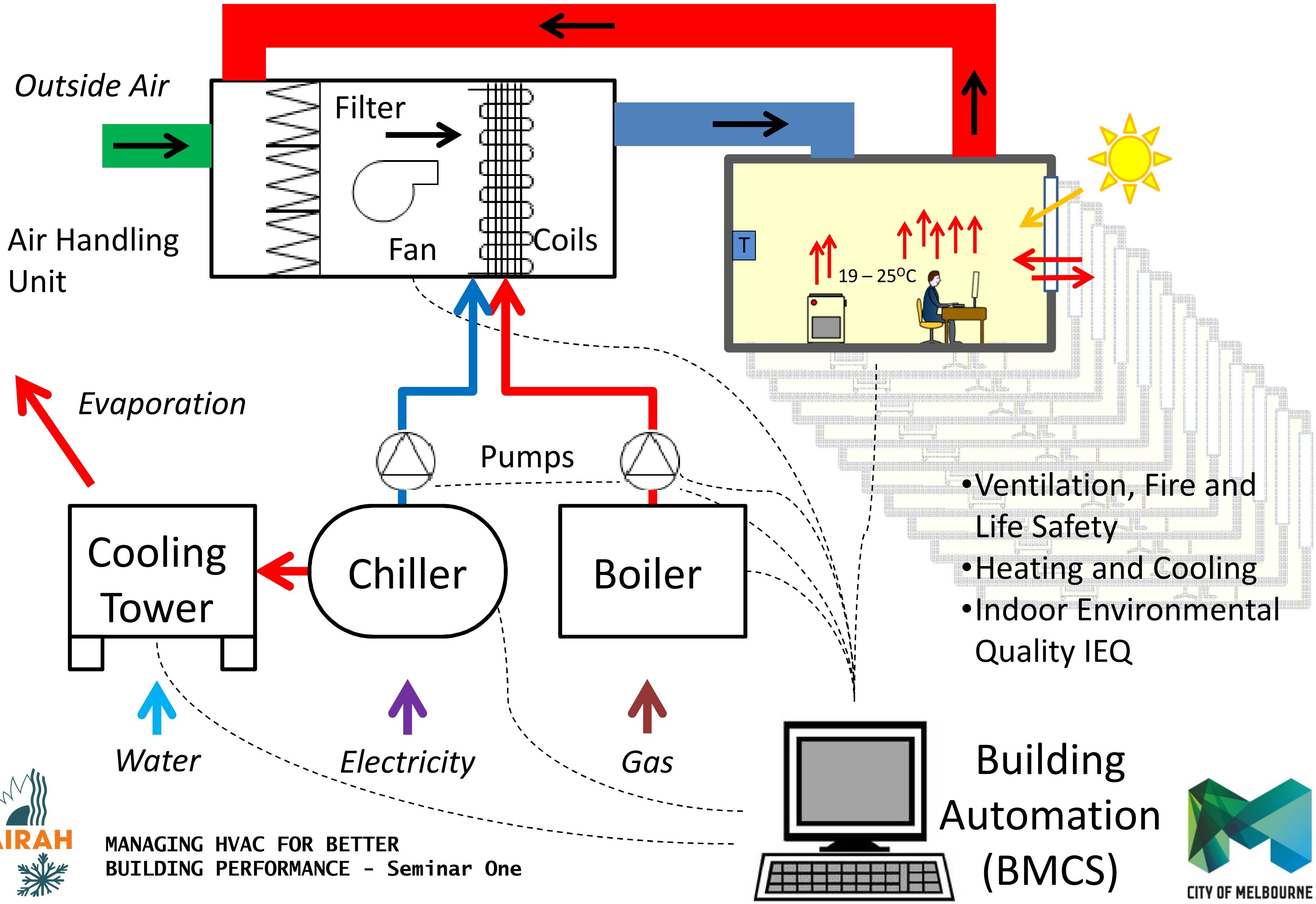


Temperature Control Methods – into room:

A. Different amount of air – same temperature (Variable Air Volume – VAV)

B. Same air – different temperature (Constant Volume – CV)

1. HVAC What it Does & How it Works



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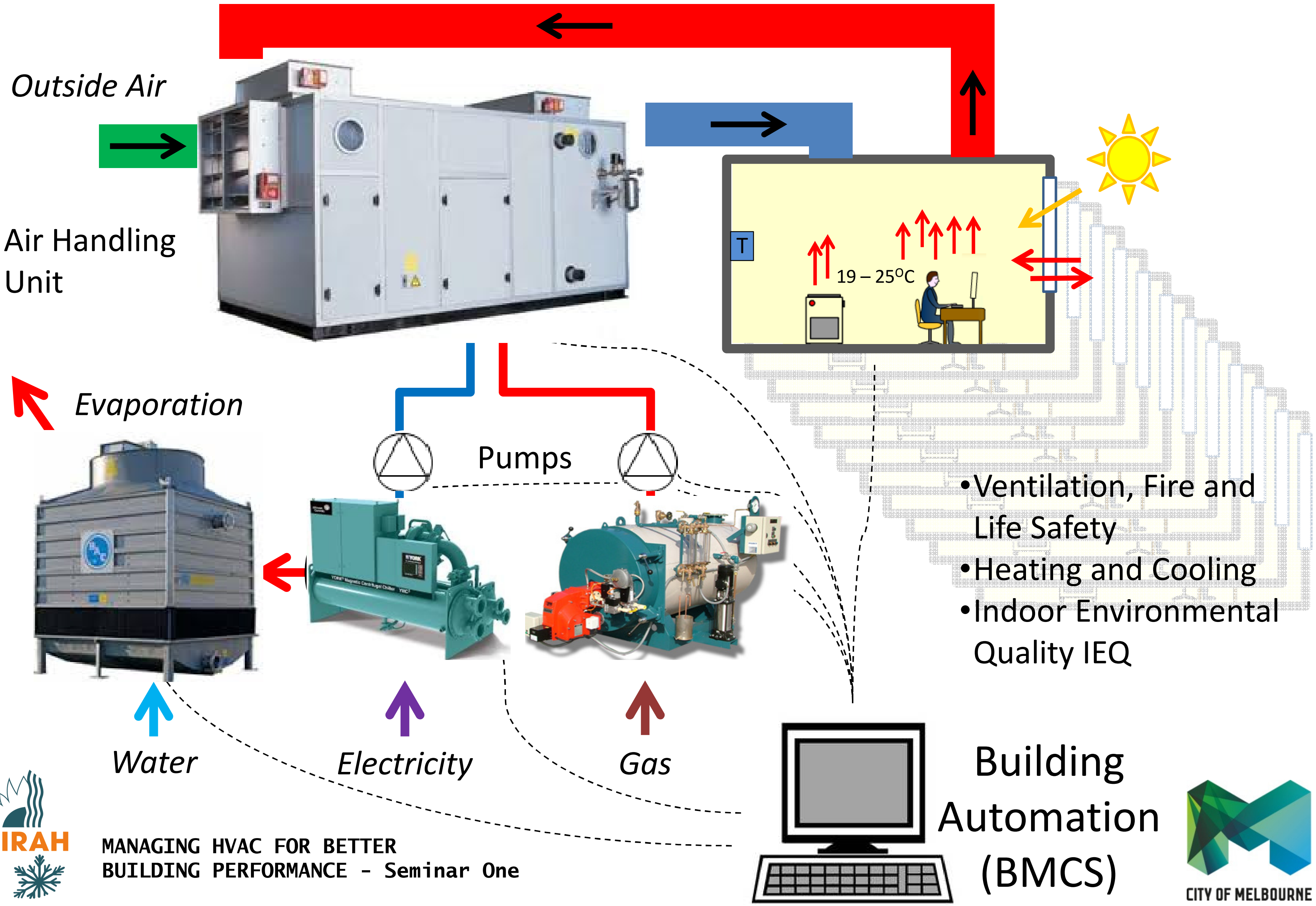
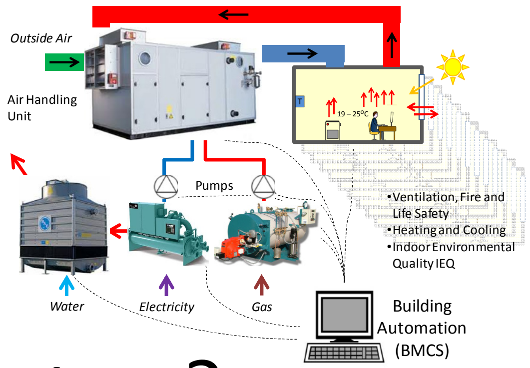


- Ventilation, Fire and Life Safety
- Heating and Cooling
- Indoor Environmental Quality IEQ

1. HVAC What it Does & How it Works

Frequently Asked Questions:

- How does HVAC use energy and water?
- How HVAC systems vary and the differences in different standards of buildings?
- Why is maintenance important?
- What are the risk issues?
- How do I get to know my HVAC system?



AIRAH TRAINING

Air Conditioning 101

Demystify the language of HVAC

An introduction to the basics of HVAC (heating, ventilation and air conditioning) in commercial buildings – this course is ideal for non-technical people employed in building operations and the services sector, or as part of an induction program for all staff.

The format includes animations to explain concepts, self-test questions for each topic to track your progress, and options for further reading. Upon completion a summary can be downloaded that provides a useful ongoing reference.

Topics covered:

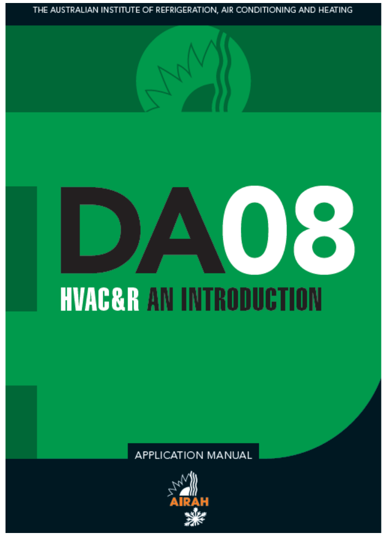
- ✓ What heats and cools a room?
- ✓ Personal comfort
- ✓ The refrigeration cycle
- ✓ Cooling towers
- ✓ Air systems
- ✓ Climate zones
- ✓ Energy and energy load
- ✓ Fire and smoke control
- ✓ Maintenance

Designed for:

- ✓ Facility managers
- ✓ Building operators
- ✓ Sales staff

Course length: 4-6 hours over 1 month

Online: start anytime



Go to:

www.airah.org.au

PART 2. Regulatory Issues

- Essential Safety Measures
- ‘Building Regulations’
- Safety
- CBD / NABERS
- Refrigerant Phase Out

2. Regulatory Issues

Essential Safety Measures

→ Essential Safety Measures Maintenance

- Legislated
- HVAC Operation in Fire Mode
  Evidence, Annual Sign Off
- Cooling Towers
  Registration, Risk Management Plans, Testing and Maintenance, Reporting, Regular Audit

Integrated Fire Mode Testing

Excerpt from A.G. Coombs Advisory Note

Modern fire protection systems are now often integrated into other building systems and require a comprehensive testing approach to assure they will operate when required.

In the past, fire protection systems in buildings were relatively straightforward and generally operated independently of other systems. Over the last 10 years, due mainly to the introduction of performance based solutions, these systems have become increasingly integrated with other building systems, especially air conditioning and ventilation systems.

While system integration can have significant benefits, it usually results in more complex systems that have a higher susceptibility to failure. Additionally, the failure of highly integrated system can have the potential to escalate the impact of a fire. For instance, an air conditioning system operating incorrectly in fire mode may actively spread smoke throughout a building.

Another issue with integrated systems is that they can be very challenging and time consuming to test and maintain to the level required to provide a high degree of surety of operation and adequately discharge duty of care obligations.

In responding to this change, installation and maintenance standards have had an increasing focus on integrated fire mode testing.

However it is important to understand the extent of testing required by these standards and the level of integrated systems surety it provides:

Testing of individual fire systems confirms the operation within the system but provides only limited confirmation of system interfaces and overall integrated operation.

Typical interface tests in line with the requirements of Australian Standard AS 1851 Maintenance of Fire Protection Systems, confirms interfaces between a detection zone and a ventilation system zone or sub system level. This may not confirm the successful operation of all items of equipment (e.g. door operations) under alarm conditions or multiple alarm zones within a building zone.

Complex integrated systems need a clear framework for testing.

Integrated Fire Mode Testing (IFMT) is a comprehensive approach to the testing of integrated systems and involves the operational testing of the functional interfaces between systems in fire mode.

Undertaken in conjunction with, or in addition to, individual system commissioning and testing IFMT will confirm that the integrated systems operate together as intended.

A key aspect when considering IFMT is determining the extent of testing needed to achieve the required level of operational surety. Idyllically, each input device in the entire integrated system would be initiated and the operation of each output or response would be confirmed. But regularly conducting such detailed testing would result in impractical timeframes and unaffordable costs. Alternatively, simple tests that verify minimal high level interfaces may not be adequate to address duty of care concerns.

The appropriate level of testing to suit the installed systems and operational requirements must be determined for a particular facility. This may include testing a number of detection Alarm Zones and confirming operation of individual items of Equipment.

The key to a successful IFMT approach is a well documented interface cause and effect matrix; usually called an Integrated Fire Mode Matrix.

This is particularly important in buildings with performance based 'fire engineered' solutions where non typical interfaces are present that are not well covered by generic standards. If a complete and accurate Fire Mode Matrix is not available this should be developed by an appropriately qualified and experienced fire services specialist.

This matrix assists in addressing the building's prescribed essential safety measures by defining the basis of the testing regime, the appropriate scope and extent of testing, and how correct operation is to be verified. The matrix also provides insights into coordination between systems specialists. A detailed test plan should be documented to assure the operation of integrated fire systems and address duty of care requirements.

2. Regulatory Issues

'Building Regulations'

- Legislated
  - Operation
  - Maintenance
  - Plumbing
  - Electrical
  - Gas
  - Refrigerants

2. Regulatory Issues

Safety

- Tenants, Visitors, Public, Contractors
- Regulations / Duty of Care

Safe Access for Building Maintenance

Excerpt from A.G. Coombs Advisory Note

Victorian Law requires building owners and occupiers to provide a safe environment for all building occupants, whether they be employees, visitors or contractors attending the site to perform maintenance or other works.

The maximum fine for breaches of the Occupational Health & Safety Act has increased from $40,000 to over $250,000 and the.

Designers of buildings and building services also have a responsibility in ensuring that facilities are designed to be safe for future owners and occupiers.

What constitutes a safe environment?

Guidelines for safe workplaces are set out in various Codes of Practice and Guidance Notes available from WorkSafe.

Particular safety considerations relating to Contractors visiting buildings to carry out maintenance or other service tasks include:

- Access to roof mounted and suspended plant; safe hardstanding and adequate top alighting space for temporary ladders, permanent ladders to be compliant with Code, safely trafficable roof surfaces, guard rails or fall arrest systems for work to be carried out near a building edge or to restrict roof traffic to safe areas, plant platforms to be compliant with Code
- Use of Plant Spaces for other purposes including storage of goods precluding access or making access unsafe
- Security, plant areas to be secured to preclude tampering with equipment
- Protection of rotating plant such as vee-belt drives, shaft drives and exposed fans
- Electrical isolation to be compliant with relevant regulations and appropriately labeled.
- Ergonomic considerations to minimise likelihood of injury whilst carrying out maintenance tasks.
- Storage of Dangerous Goods in plant spaces where contractors could be exposed
- Signage of hazardous access issues including non trafficable roof areas, head height issues, confined space and excessive noise

Contractor's OH&S Procedures

Contracting organisations have a legal obligation to provide safe working conditions for their employees. To manage these risks most organisations have OH&S Policies and Procedures in place. Contractor's OH&S procedures will usually prohibit their staff going into unsafe environments until appropriate measures are in place. This may preclude maintenance and other activities being carried out.

Contractors working in unsafe situations put building owners and occupiers at risk of prosecution and litigation in case of accident.

Safe and ready access to plant facilitates effective maintenance and can result in lower costs.

For more information contact:

Victorian Work Safe www.worksafe.vic.gov.au/

2. Regulatory Issues

CBD / NABERS

- Mandated disclosure of NABERS Energy rating on lease or sale of commercial space > 2000sqm

Commercial Building Disclosure Program – 'Mandatory Disclosure' - May 2011

Excerpt from A.G. Coombs Advisory Note

With the passing of the Building Energy Efficiency Disclosure Bill 2010, the disclosure requirements under the Commercial Building Disclosure (CBD) program came into effect on 1 November 2010.

The aim of the program is to ensure that credible and meaningful energy efficiency information is given to prospective purchasers and lessees of large commercial office space. Initially the program requires owners and lessors of commercial office space with a net lettable area of 2,000m² or more, to disclose the energy efficiency rating to prospective purchasers and tenants when the space is to be sold, leased or subleased.

Transitional provisions

The legislation contains transitional provisions that will apply for the first twelve months of the program until November 2011. During this period, a valid National Australian Built Environment Rating System (NABERS) Energy base or whole building rating obtained up until the end of the transitional period, can be disclosed instead of a full Building Energy Efficiency Certificate (BEEC). The NABERS Energy star rating will need to be disclosed in any advertisement about the sale, lease or sublease of the office.

Building Energy Efficiency Certificate

The requirements to disclose a Building Energy Efficiency Certificate (BEEC) will commence in the second year of the program (November 2011) and must include three components:

1. NABERS Energy base building rating
2. Tenancy lighting assessment
3. Energy efficiency guidance.

The BEEC will be valid for up to 12 months. At the time of disclosure, the certificate will need to be valid, current and registered on the scheme's online central registry. The NABERS Energy star rating will need to be disclosed in any advertisement about the sale, lease or sublease of the office.

It should be noted that 12 consecutive months of energy consumption and related operational information is required for a NABERS Energy rating. If a base building rating cannot be obtained due to inadequate metering, a whole building rating will need to be disclosed.

Importantly, NABERS Energy ratings disclosed under the program must be exclusive of green power.

Tenancy lighting assessment and energy efficiency guidance

The tenancy lighting assessment will benchmark the existing tenancy lighting against best practice. Accredited assessors will complete a survey of the lighting and enter data into a calculator.

The energy efficiency guidance will provide general advice to building owners and tenants on common energy efficiency opportunities in commercial office buildings. The material will not be tailored to the individual building and will not be an energy audit. The program does not require building owners to undertake a comprehensive energy audit.

Both the tenancy lighting assessment and energy efficiency guidance will not be required during the transitional period.

Accredited Assessors

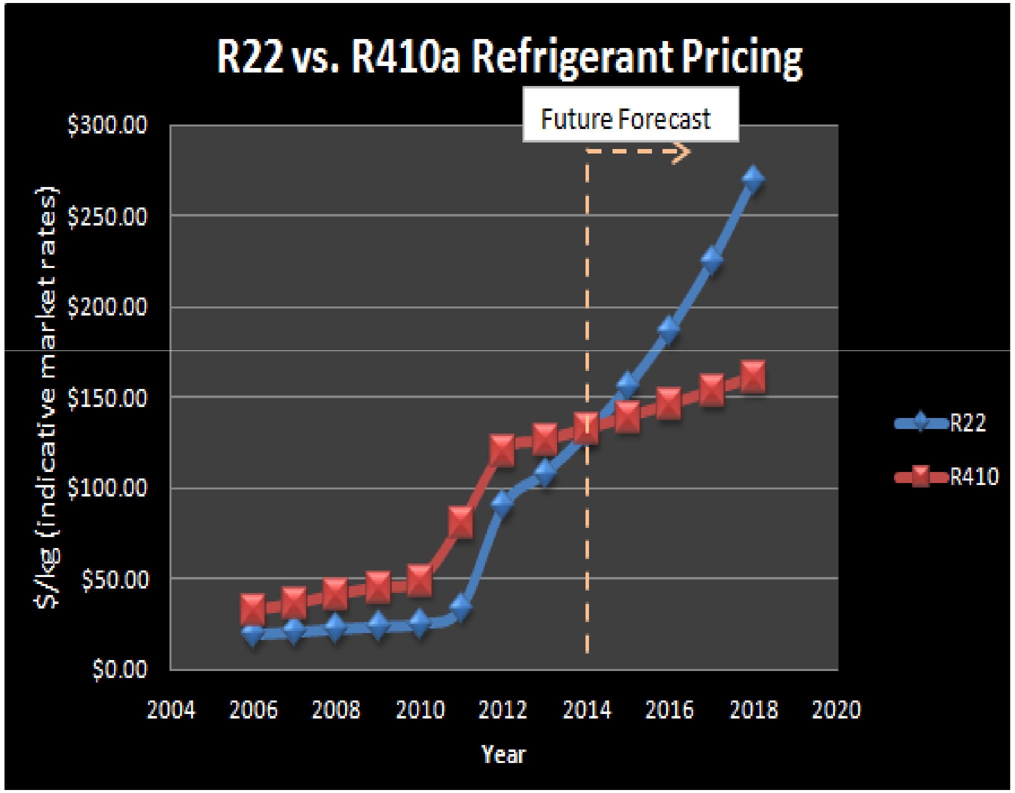
Assessments for BEECs will be undertaken by NABERS assessors who have also been accredited under the CBD program. Accredited NABERS assessors do not need to be accredited under the program to assess buildings under the transitional provisions.

For guidance on the scheme, information about obtaining a NABERS Rating, a BEEC or guidance on improving energy efficiency contact:

2. Regulatory Issues

Refrigerant Phase Out

- 2016 key date
- Economic and Risk issue
  - Cost of R22
    Small Chiller $33,000
  - Availability of gas and parts



Source A.G. Coombs Group 2013

Refrigerant Management Guidelines
Excerpt from A.G. Coombs Advisory Note

1. Ensure that all refrigeration based plant is identified on **asset lists**, and is incorporated into a preventative maintenance program.

2. Update asset lists to include the **type of refrigerant used and quantity**.

3. Review the risks. As an example, a medium sized chiller may hold well over 100kg of refrigerant. If the refrigerant is R134a, the refrigerant replacement supply cost has gone from $6,572, to $18,172. Large chillers can have 800kg of refrigerant ($145,376). **Early leak detection systems are available** and can represent a relatively inexpensive means of limiting the risk of major refrigerant loss.

4. Review maintenance frequencies and practices based on the risk associated with the increased asset value. **Enhanced maintenance arrangements** should minimise the likelihood and extent of refrigerant loss.

5. Consider **security risk**. Cylinders should not be left in unsecured areas. A small 20kg cylinder of R410A, now has a potential replacement value of over $5,000. Consider also the security of externally located plant including the installation of protective enclosures to prevent refrigerant theft.

6. Develop **replacement plans for R22 equipment**. Replacement parts have become more difficult and expensive to source with some parts now virtually unavailable. Whilst not affected by the SGG Levy, the cost of R22 has increased markedly and rapidly with further significant cost escalation and ultimately shortages in supply certain.

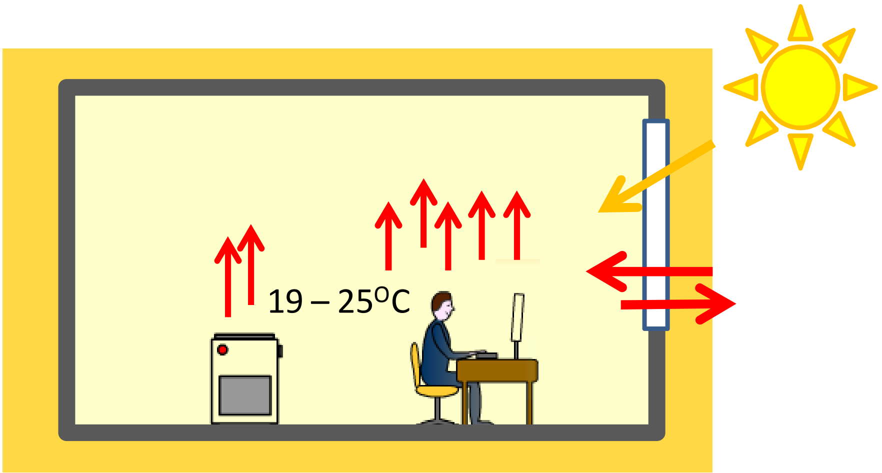
7. Review **energy efficiency options** to reduce the size of the replacement equipment or enable it to work more efficiently. Replacing R22 equipment with new plant may result in improvements in energy efficiency and reductions in operating energy costs of between 15 – 45% and more in some circumstances.

A.G. Coombs Advisory Notes are an information service developed to keep industry better informed and up to date on building issues, particularly in the changing areas of regulatory and industry standards. Current Advisory Notes can be accessed at: http://www.agcoombs.com.au/resources/advisory_notes

PART 3. Ownership Issues

- System Performance
- Regulatory Compliance
- Maintenance and change
- Energy and water
- Costs
- Lifecycle

3. Ownership Issues



System Performance

- Tenant satisfaction
  Complaints, Rent, Vacancy
- Lease conditions

Melbourne CBD Vacancy Rates – December 2013

Grade	Stock (sq m)	Vacancy (sq m)	Vac % Dec-13	Vac % Dec-12
Premium	571,052	52,587	9.2	6.9
A Grade	1,509,629	109,480	7.3	6.1
B Grade	822,992	114,819	14.0	8.1
C Grade	564,552	65,297	11.6	12.0
D Grade	121,152	3,465	2.9	2.2
Total	3,589,377	345,648	9.6	7.5

Source: Property Council of Australia / Savills Research

3. Ownership Issues

Regulatory Compliance

- Essential Safety Measures, Building Regulations, WorkSafe etc
- Management Controls and Records Keeping

3. Ownership Issues

Maintenance and Change

- Maintenance
  - Trusted providers
  - Clear understanding of responsibilities
  - Management and records keeping
- Change; replacement, upgrade, retrofit
  - Knowledge
  - Planning
  - Process
  - Management and Resources

3. Ownership Issues

Energy and water

- Measuring and metering
- Supply Contracts
- What's possible

Managing Water Usage in Cooling Towers
Excerpt from A.G. Coombs Advisory Note

Cooling towers are responsible for the consumption of large amounts of potable water. A cooling tower installation serving a large commercial building may consume in excess of 500,000 litres of water in a week through the evaporative effect alone.

With concerns increasing over water consumption and its future scarcity water usage in cooling towers has become an important issue that we must manage.

There are six ways in which water is used in cooling towers:

Evaporation: As part of the heat rejection process, as a general rule the greater the heat rejection the greater the evaporation rate . It is however a complex relationship with a number of variables including flow rates, cooling tower design, fan operation and effectiveness, wet and dry bulb ambient temperatures, prevailing wind conditions, condenser water temperature set points and system control regimes. A well managed system whether it be industrial plant or building air-conditioning will reject less heat, use less energy and consume less water.

Bleed: Because of the evaporative effect the concentration of dissolved salts in the system will increase leading to scale and deposit build up and corrosion. Automatic 'bleed' systems work to manage and limit concentration levels by draining water and replacing it with fresh water. The bleed can be at a set rate by fixed valve or timed discharge, or it can be variable based on sensing the water properties as they are affected by dissolved salts e.g. conductivity. Either method can result in excessive bleed rates if the system is not set up properly and checked regularly.

Carry Over or 'Drift': Inappropriately sized cooling towers, poorly modified cooling towers, cooling towers with ineffective or no drift eliminators can all result in excessive amounts of carry over or drift in the discharge air. Aside from the water wastage aspect this is a public health risk circumstance and is now the subject of strong regulatory control in most Australian States. There should be minimal carry over from cooling towers.

System leakage: Because cooling tower systems are 'open systems' leakage often goes unnoticed. Leaks may be due to faulty glands in pumps or a number of other sources. The rate of system water loss from splash out from cooling tower basins and exposed fill can be significant in poorly designed installations. Systems should be audited regularly and leaks rectified.

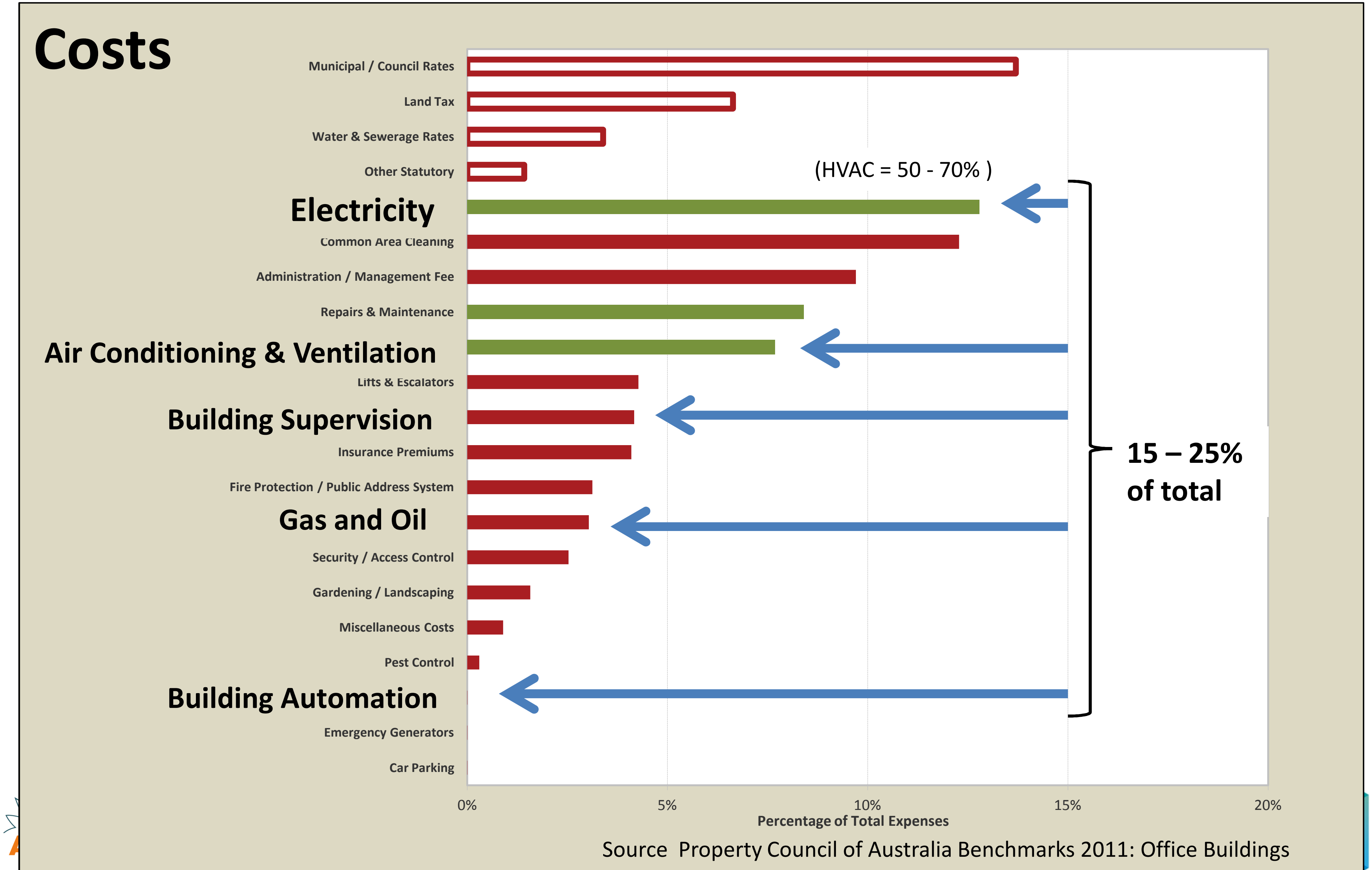
Cleaning and Remedial Actions: Draining down cooling towers and systems for scheduled cleaning and as a part of the 'disinfect - clean - disinfect' remedial process required by law now consumes significant amounts of water. Cleaning with high-pressure washers also uses large amounts of water. These activities are by and large at present carried out with little or no regard to the amount of potable water consumed. There needs to be a heightened awareness of water usage during these activities and water should be conserved where possible without compromising public health.

Maintenance of system components: Maintenance, modification and repair of cooling tower system components such as chillers, pumps, valves and heat exchangers can sometimes require the drain down of the system. These activities are often carried out with little or no regard to the amount of potable water consumed.

There are a number of areas that need attention and a strategic approach is required to manage and minimise water consumption in cooling tower systems. Water usage in cooling tower systems should be accounted for. It is possible to develop and monitor a water balance for the system to ensure water consumption is managed and not wasted. To accurately measure water consumption the incoming make-up water, wash down water and bleed discharge water should be metered. Specific activities that consume water such as drain downs should be recorded and the consumption event noted.

An increased awareness of the amount of water used by cooling towers must be encouraged and plant management and maintenance practices need to be improved to reduce water consumption.

3. Ownership Issues



3. Ownership Issues

Indicative Costs; System and Maintenance

- New HVAC system incl. BMCS installation cost ≈ $450–750 sqm
- Typical Components
  - Chiller ≈ $120,000 - $650,000 installed
  - Pump ≈ $3,500 - $15,000 installed
- HVAC maintenance + repair cost, new plant ≈ $5–8 sqm p.a.
- HVAC Maintenance + repair cost, old plant ≈ $10–15 sqm p.a.
- Essential Services Maintenance ≈ $1 sqm p.a.
- Programmed maintenance (perform/asset) ≈ $4–6 sqm p.a.

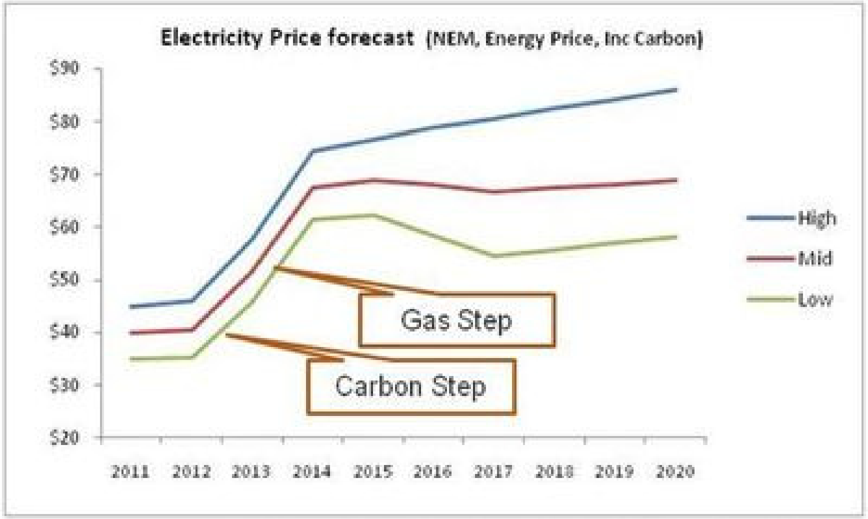
3. Ownership Issues

Indicative Costs; Utilities - Comparison

Utility	1.5 NABERS Energy Star $sqm p.a.	4.5 NABERS Energy Star $sqm p.a.	% Improvement 1.5 → 4.5 Star	
Typical electricity cost	$19.48	$8.18	$11.30	58%
Typical gas cost	$2.13	$0.89	$1.24	58%
Typical water cost with cooling towers	$3.26	$1.49	$1.77	54%
Totals	**$24.87**	**$10.56**	**$14.31**	**58%**
Example: 5,000 sqm commercial building	$124,350.00	$52,800.00	$71,550.00	58%

3. Ownership Issues

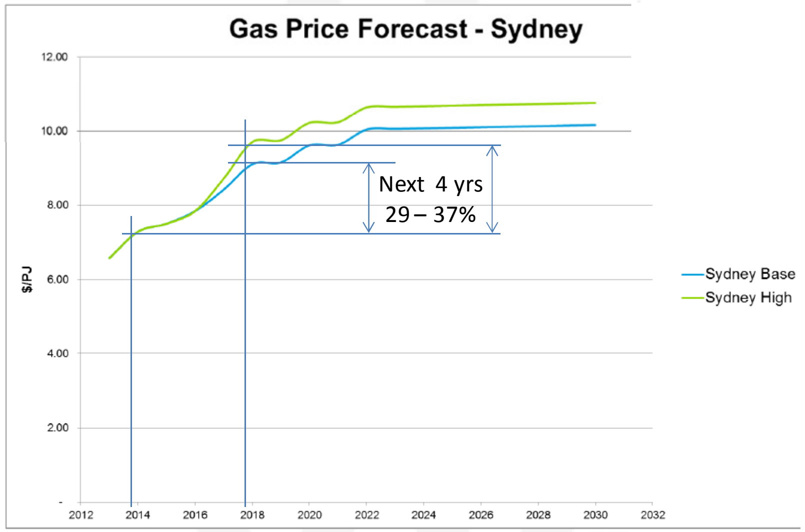
Indicative Costs; Utilities - Escalation



Source Energetics

Future electricity prices (NEM – East Coast)

Gas Price Forecast – Sydney Sets the Price ($2013)



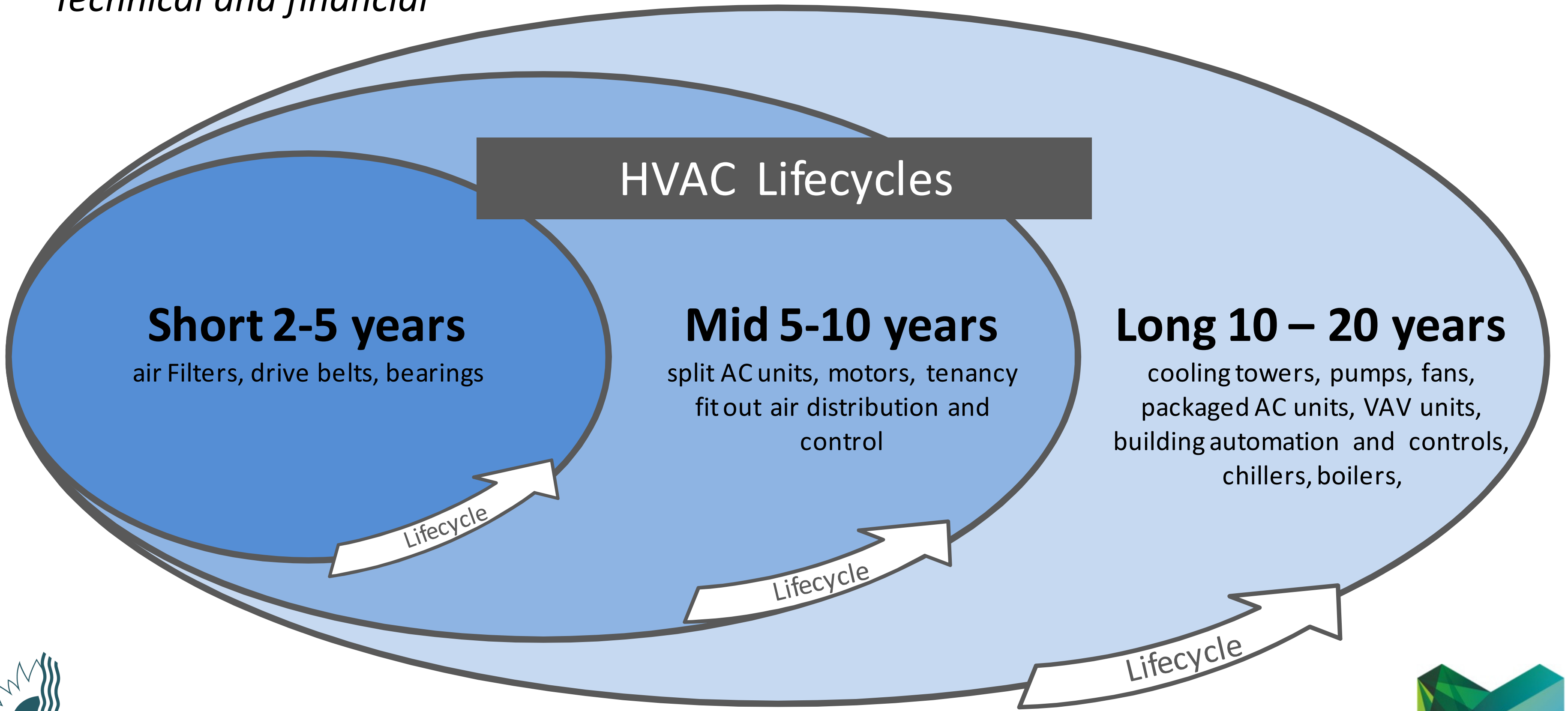
Source Oakley Greenwood EEC Conference Dec 2013

MANAGING HVAC FOR BETTER
BUILDING PERFORMANCE - Seminar One

3. Ownership Issues

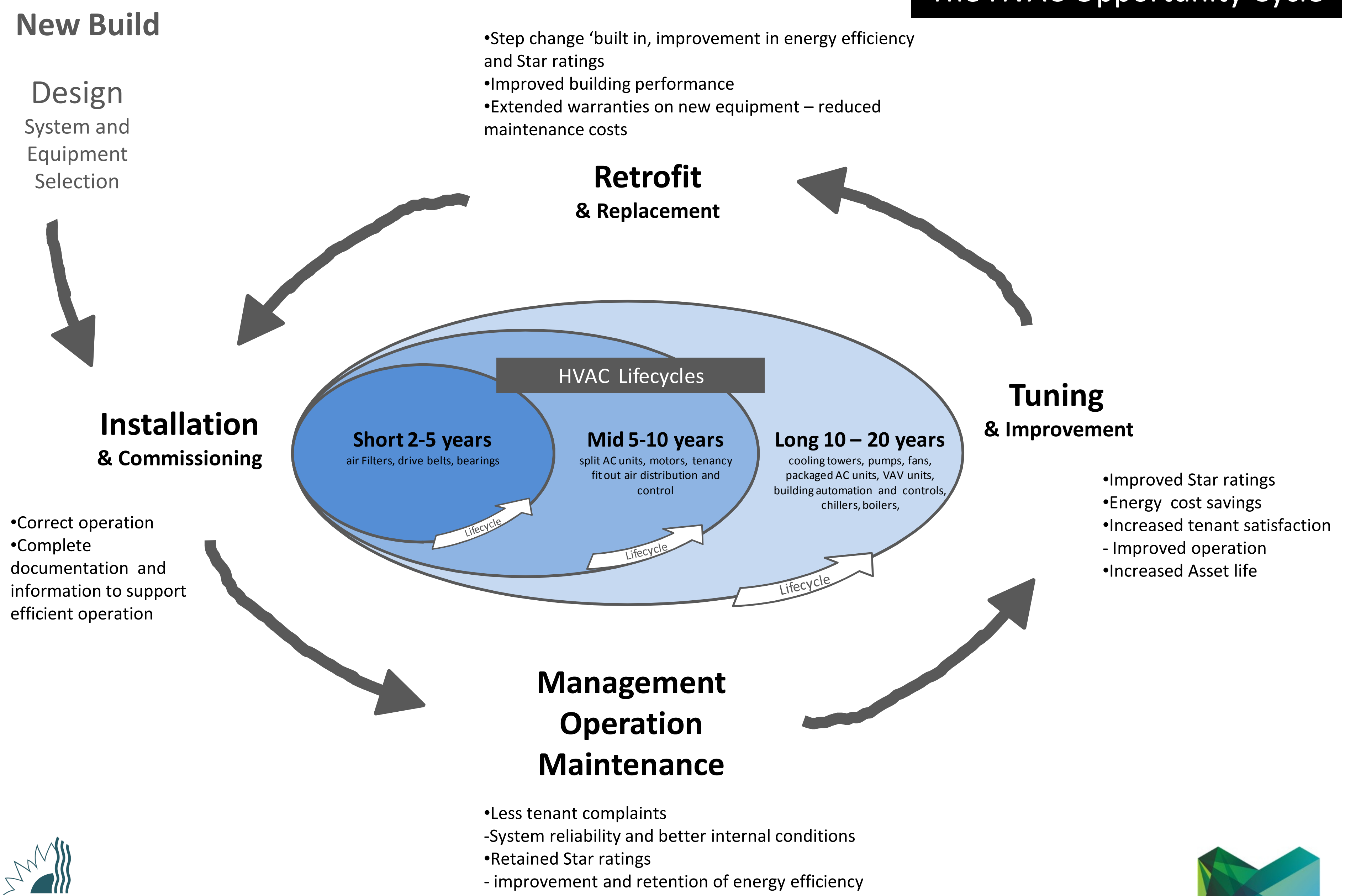
Lifecycle

Technical and financial



Source: AIRAH Handbook 2000

The HVAC Opportunity Cycle



3. Ownership Issues

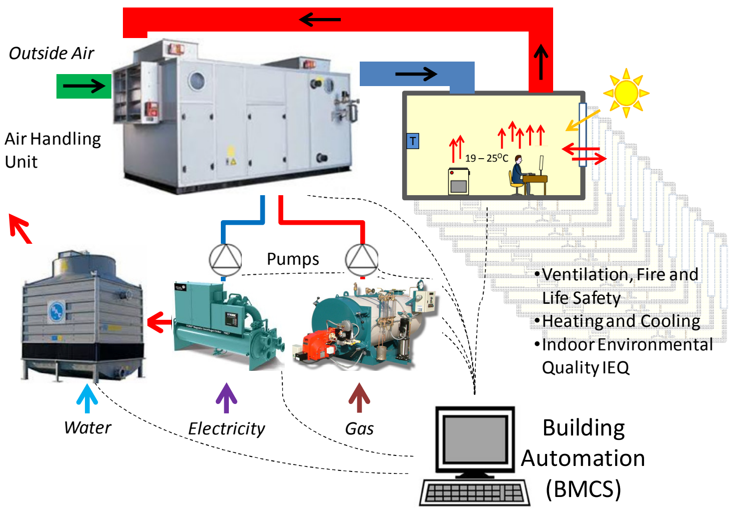
Lifecycle - The 'CAR' analogy

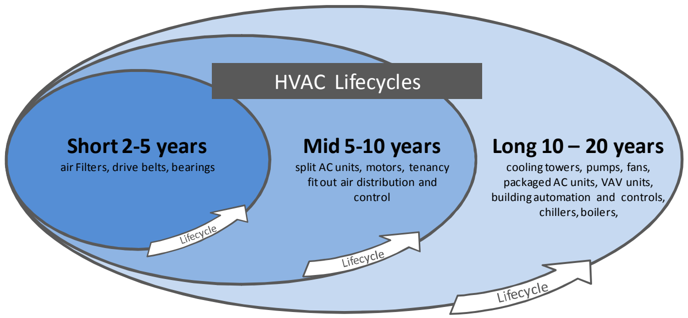
- Amenity
  utility, comfort, reliability, safety, standard
- Compliance
  regulations, lease
- Cost
  energy, maintenance, compliance, management, finance
- Lifecycle
  technical and financial - planning, management, measure and report

Source: AIRAH Handbook 2000

Seminar 1 - Recap

HVAC Explained, Ownership Requirements and Issues





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- Explain its role in providing comfort and ventilation
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- How HVAC uses energy and water
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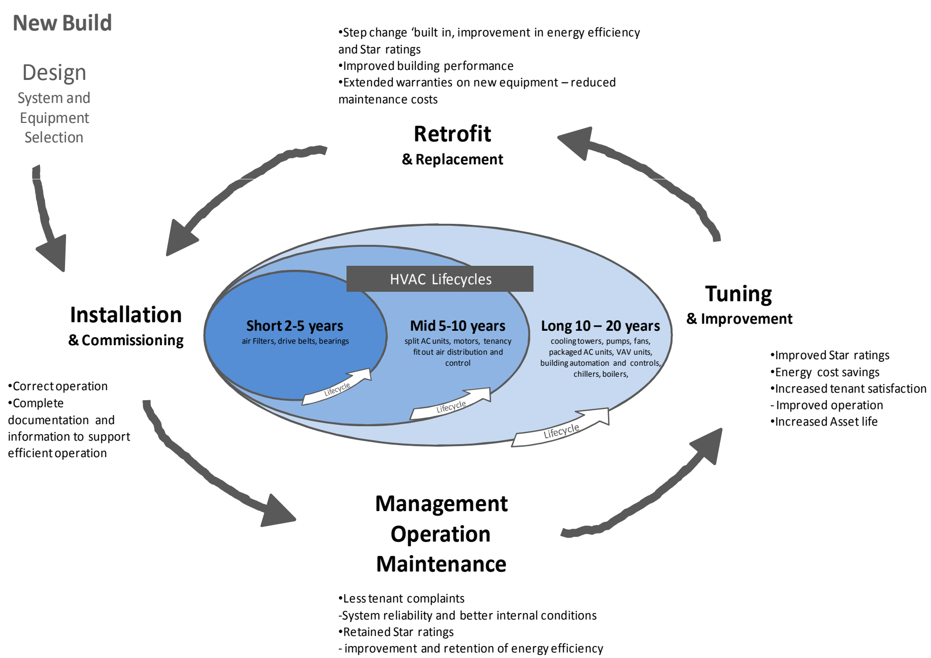
Seminar 2 – Looking Ahead

<u>Seminar 2 - Wednesday 14 May 2014</u>

HVAC Management;

Improvement Opportunities



4. Management and Operation

- System performance, internal conditions, health and safety, energy and water, modifications, maintenance, tuning, engagement, metering, documentation and records
- Managers – Occupiers – Service providers / maintainers

5. Maintenance

- Essential safety measures
- Preventative vs reactive (breakdown)
- Energy and water implications

6. Lifecycle Opportunities

- Replacement
- Upgrades
- Retrofits

7. Improvement Planning & Delivery

- Objectives and outcomes
- Maintenance, Tuning and Operations
  - Engagement and Procurement
- Investment in Change
  - replacement/upgrade/retrofit
- Keeping the benefits

BLOWING HOT AND COLD

How to retrofit and manage heating, ventilation and air conditioning systems in commercial buildings

Seminar 1: How Does HVAC Work, Ownership Requirements and Issues

Presenter - Bryon Price
Board Member - Australian Institute of Refrigeration Air Conditioning and Heating
Strategic Development Director - A.G. Coombs Group

AIRAH

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