BLOWING HOT AND COLD

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

Seminar 2: HVAC Management and Improvement Opportunities

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. Installation & Commissioning

- Correct operation
- Complete documentation and information to support efficient operation
- Getting what you paid for
- Foundation for improvement

5. Management, Operation & Maintenance

- Less tenant complaints
- Legal Compliance
- Retained Star ratings
- Reduced overall costs

6. Tuning & Improvement

- Improved Star ratings
- Energy and water cost savings
- Improved system performance
- Increased Asset life
- Knowledge of system

7. Replacement & Retrofit

- Renewed asset
- Step change 'built in, improvement in energy efficiency and Star ratings
- Improved building performance
- Extended warranties on new equipment and reduced maintenance costs

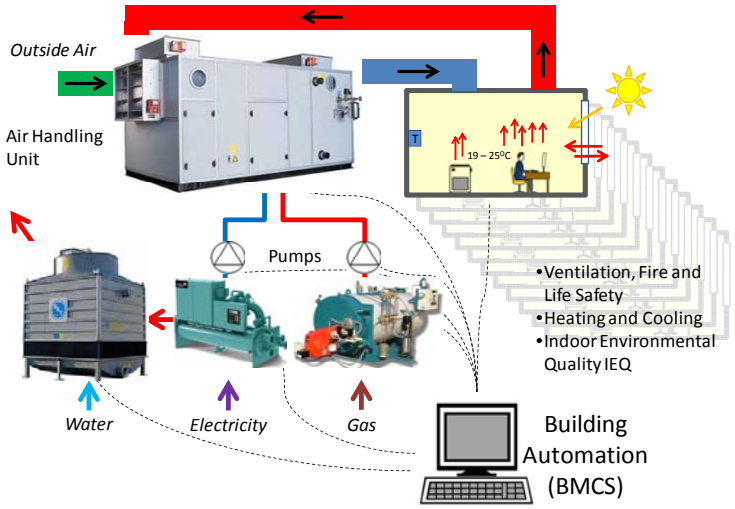
AIRAH

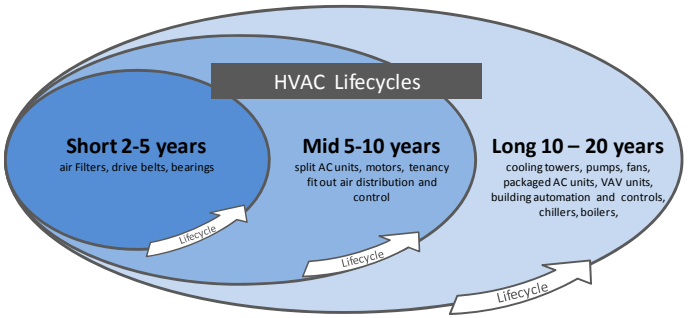
MANAGING HVAC FOR BETTER BUILDING PERFORMANCE - Seminar Two

CITY OF MELBOURNE

Seminar 1 Recap /

HVAC Explained, Ownership Requirements and Issues





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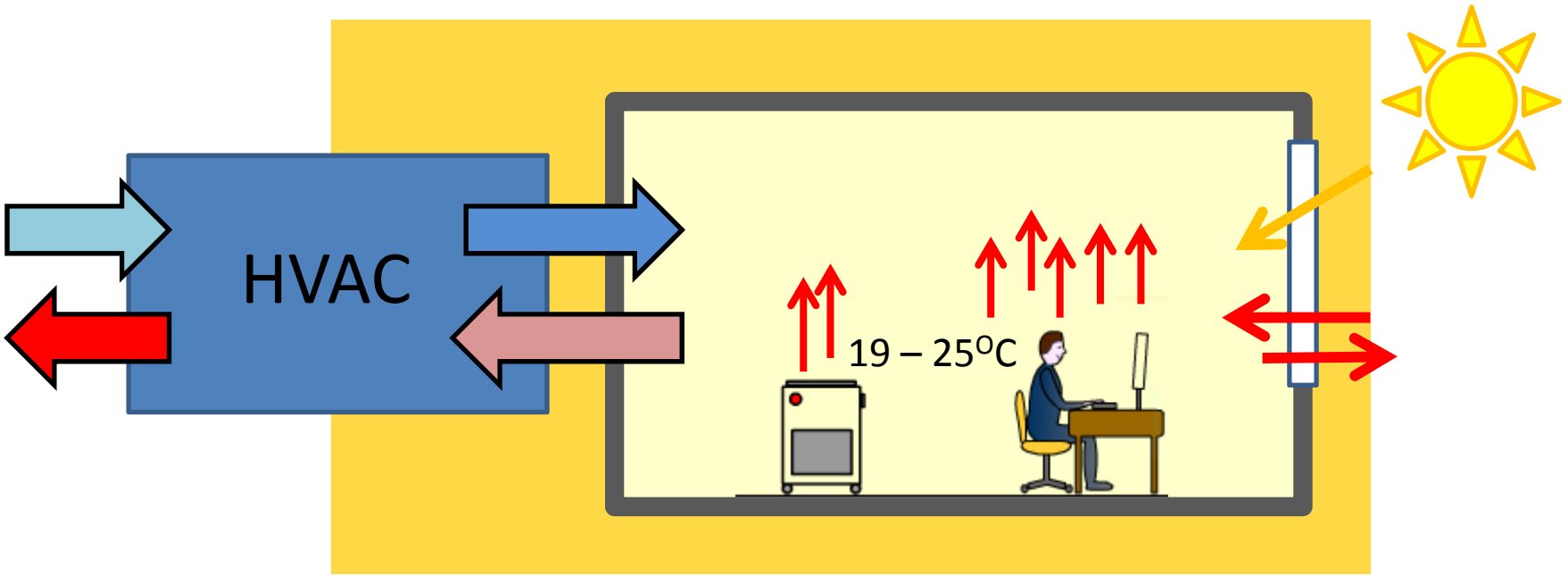
MANAGING HVAC FOR BETTER BUILDING PERFORMANCE - Seminar Two

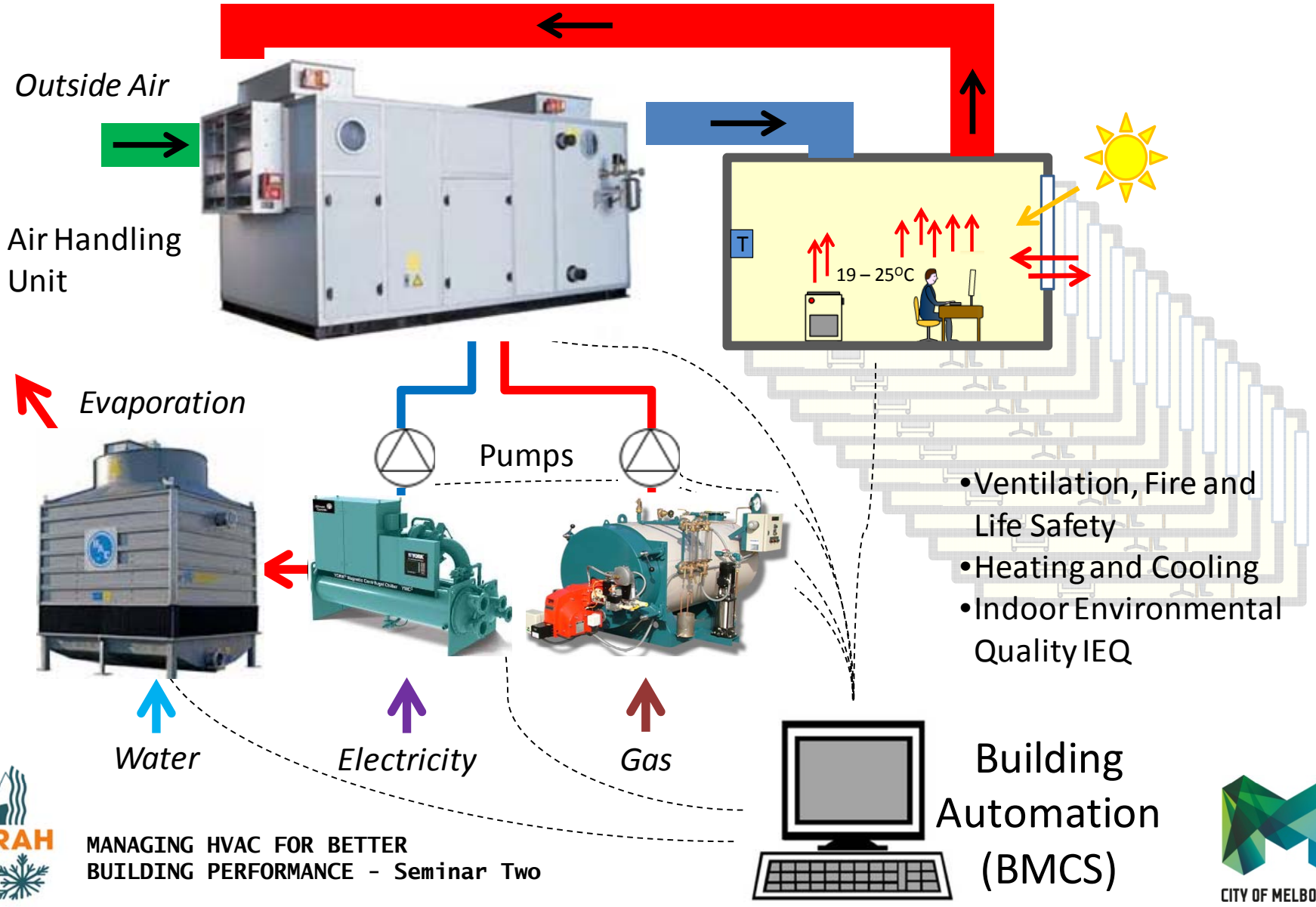
CITY OF MELBOURNE

Seminar 1 Recap / 1. HVAC What it Does



- Ventilation / Fire Mode smoke management
- Cooling / Heating
- Indoor Environmental Quality / Filtration

Seminar 1 Recap / 1. HVAC How it Works



Seminar 1 Recap / 2. Regulatory Issues

- Essential Safety Measures
- ‘Building Regulations’
- Safety
- CBD / NABERS
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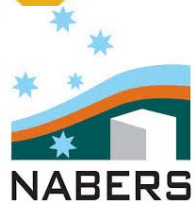

Seminar 1 Recap / 3. Ownership Issues

- System Performance
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- Energy and water
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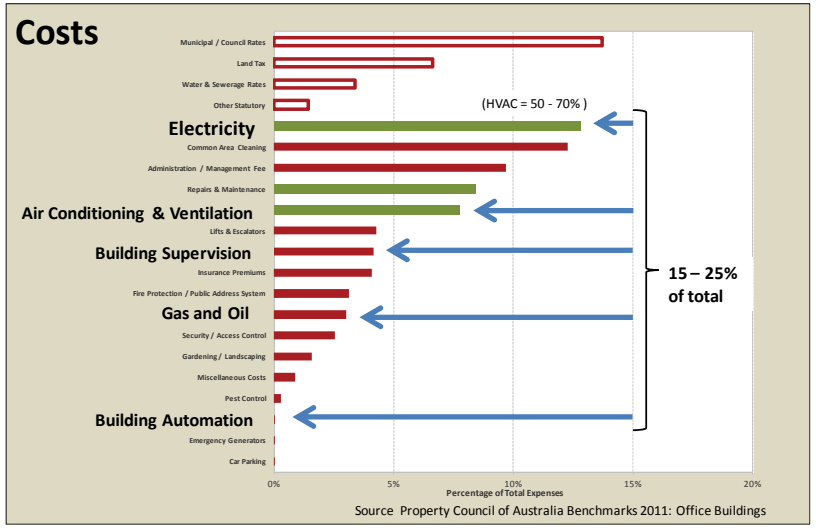
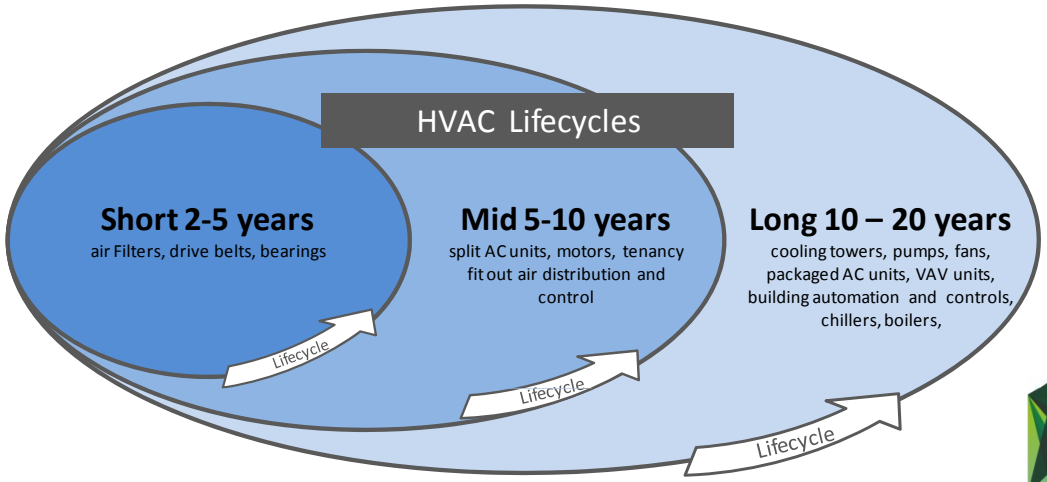
- Lifecycle





Seminar 1 Recap / 3. Ownership Issues

Indicative Costs; System and Maintenance

- New HVAC system incl. BMCS installation cost ≈ $450–750 sqm
- Typical Components
  - Chiller ≈ $220,000 - $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.

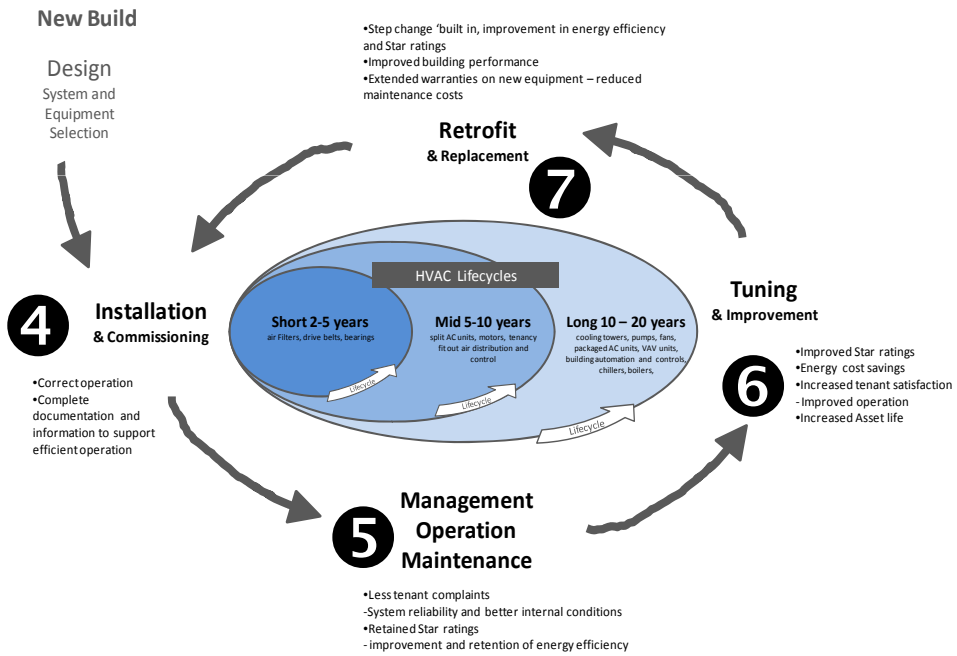
Seminar 1 Recap / 3. Ownership Issues

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%

Seminar 2 – Today

HVAC Management; Improvement Opportunities



4. Installation & Commissioning

- Correct operation
- Complete documentation and information to support efficient operation
- Getting what you paid for
- Foundation for improvement

5. Management, Operation & Maintenance

- Less tenant complaints
- Legal Compliance
- Retained Star ratings
- Reduced overall costs

6. Tuning & Improvement

- Improved Star ratings
- Energy and water cost savings
- Improved system performance
- Increased Asset life
- Knowledge of system

7. Replacement & Retrofit

- Renewed asset
- Step change 'built in, improvement in energy efficiency and Star ratings
- Improved building performance
- Extended warranties on new equipment and reduced maintenance costs

The HVAC Opportunity Cycle

NEW BUILD

Design
System and Equipment Selection

4 INSTALLATION & COMMISSIONING

- Correct operation
- Complete documentation and information to support efficient operation

5 MANAGEMENT OPERATION MAINTENANCE

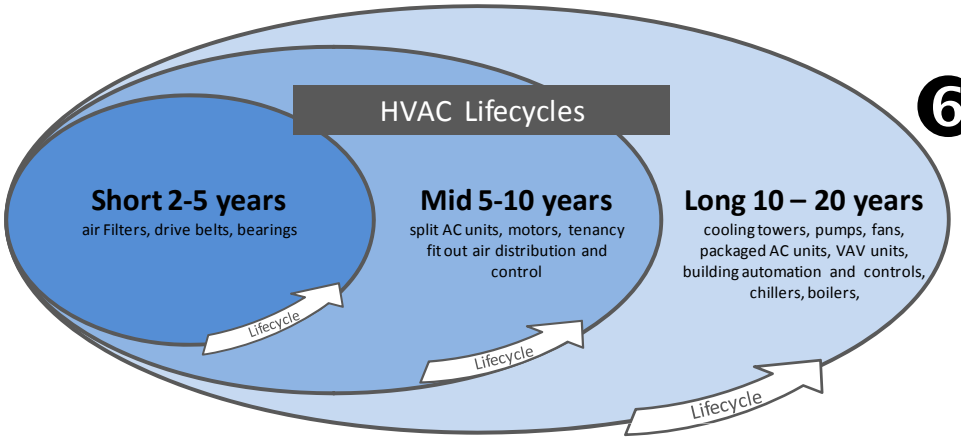
- Less tenant complaints
- System reliability and better internal conditions
- Retained Star ratings
- improvement and retention of energy efficiency

6 TUNING & IMPROVEMENT

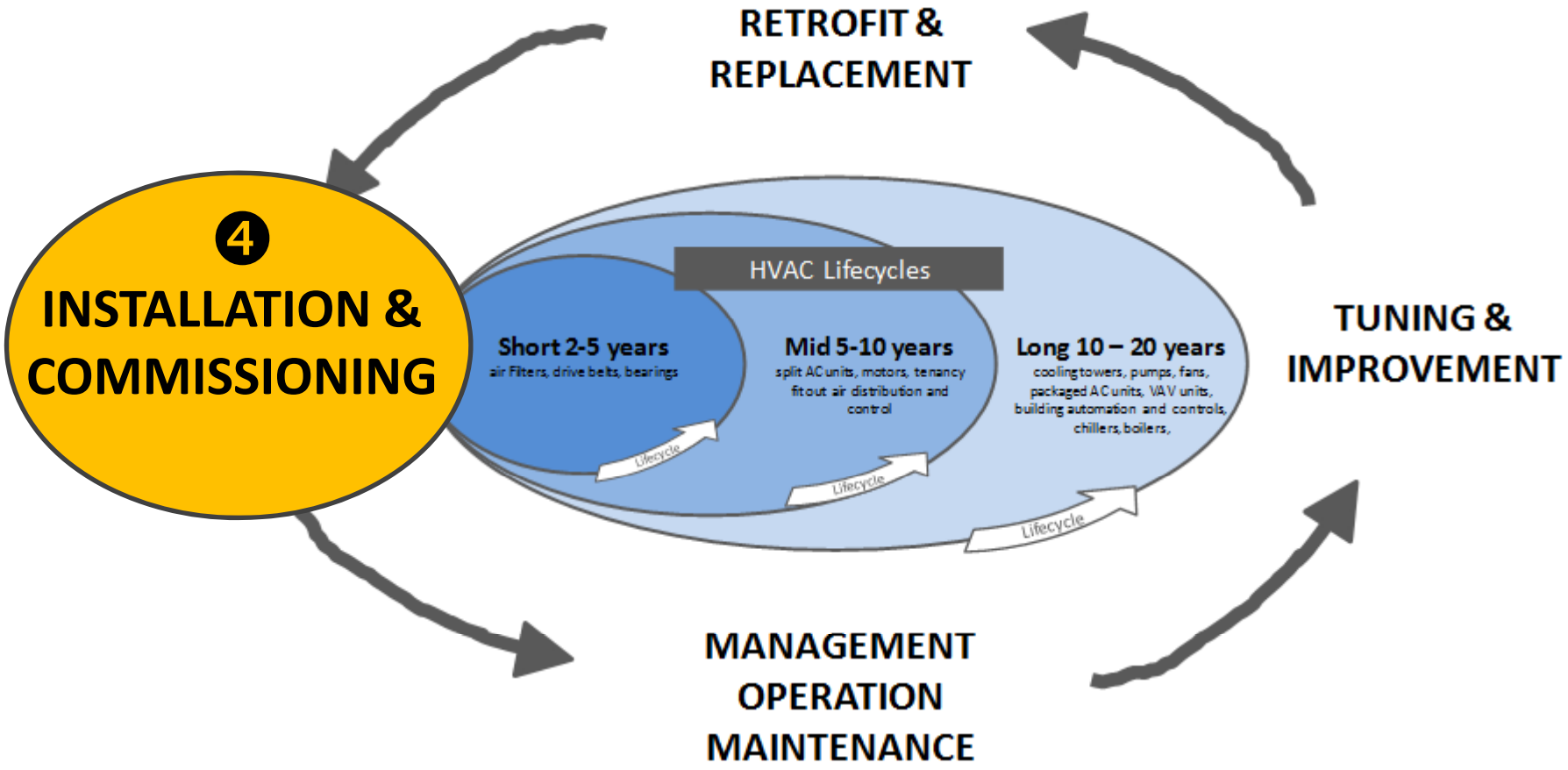
- Improved Star ratings
- Energy cost savings
- Increased tenant satisfaction
- Improved operation
- Increased Asset life

7 RETROFIT & REPLACEMENT

- Step change 'built in, improvement in energy efficiency and Star ratings
- Improved building performance
- Extended warranties on new equipment – reduced maintenance costs



PART 4. Installation & Commissioning



4. Installation & Commissioning

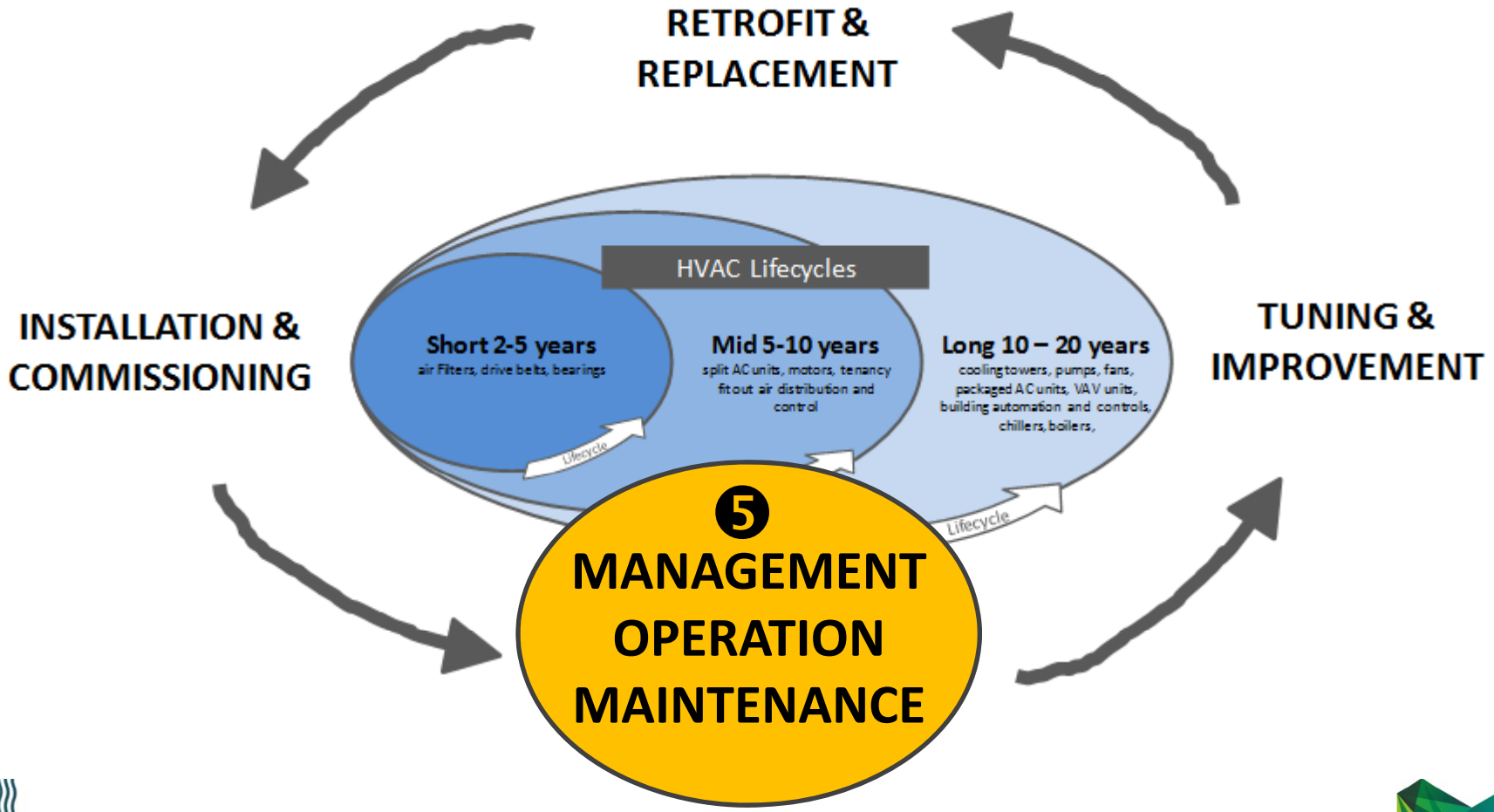
What's to be Had?

- Correct ‘best’ operation
- Complete documentation and information to support efficient operation
- Getting what you paid for!
- Foundation for improvement

4. Installation & Commissioning

- Like for like?
  - Size, performance, features
- Inspect; access for maintenance, quality etc
- Commissioning records
  - Proof of correct operation
  - Future changes
  - Tuning
- National Environmental Balancing Bureau *qualified commissioning technicians*

PART 5. Management, Operation & Maintenance



5. Management, Operation & Maintenance

What's to be Had?

- Reduced tenant complaints
  - Better internal conditions and system reliability
- Legal Compliance
- Retained Star ratings – risk management
  - Retention and improvement of efficiency (-1.5 – +0.5)
- Reduced overall costs - Lifecycle
  - Maintenance + breakdown + replacement

5. Management, Operation & Maintenance

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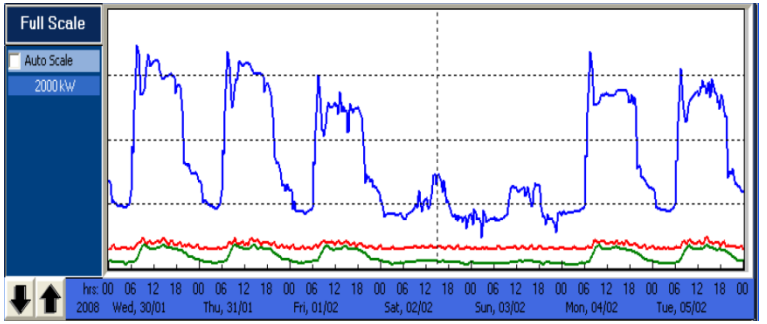
5. Management, Operation & Maintenance

Management

- Performance, Asset and Service Providers
  - Total Cost thinking
- Documentation and Records keeping
  - Performance, compliance costs, energy and water, assets; *as-installed's* and manuals, refrigerant
- Utility Supply Contracts
  - Adjust load and usage to best advantage

5. Management, Operation & Maintenance



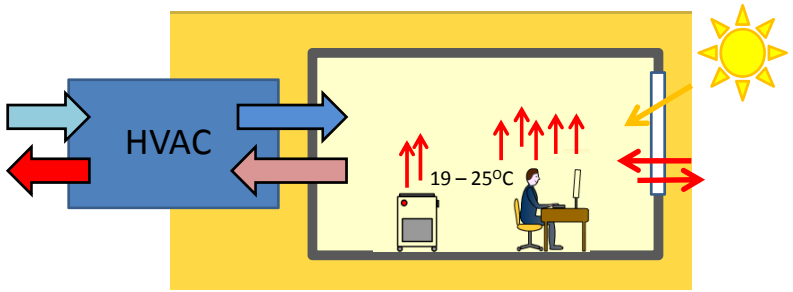
Operation

- Low hanging fruit
  - Stop / Start Hours of operation
  - Tenants; Out of hours
  - Alarms, plant starts, hours run, Auto/Manual
- Change Management
  - Planning; asset register, lifecycle, refrigerants
  - Control; access, modifications (Base building engineer role), project management

Metering and Monitoring
Energy and Water

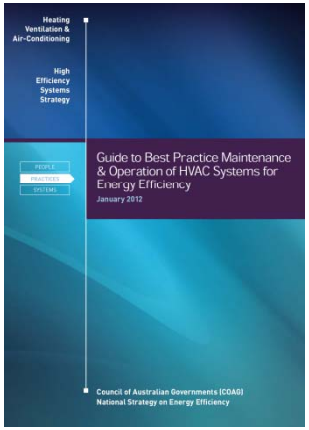
- Define requirements
  - NABERS/Green Star/Energy Management
  - Metering Tree
  - Accuracy and reliability
- Type of meter
- Installation standards
- Meter management
- Data - its more than ‘just energy’
- Data capture and storage
- Monitoring and reporting
  - By whom, how, who to and why?
  - Dashboards; management, tenants and public

5. Management, Operation & Maintenance



Maintenance

- System performance
- Compliance
  - ESM ; fire mode/cooling towers
  - Building Reg's, Safety, Refrigerants
- Asset lifecycle
  - Costly plant
  - Refrigerants
- Energy and water efficiency
  - Prevent energy wastage
- Trusted providers – 'trust but verify'
  - Clear understanding of responsibilities
- Guidance?



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.

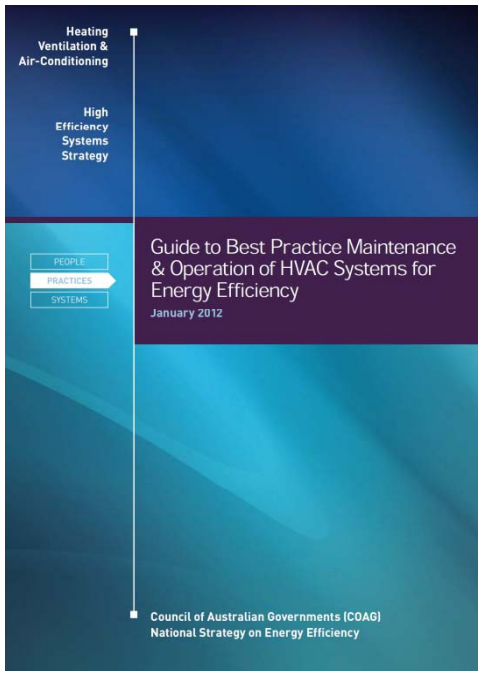
5. Consider **security risk**. Cylinders should not be left in unsecured areas. A small 20kg cylinder of R410A, now has a potential replacement value of over $5,000. Consider also the security of externally located plant including the installation of protective enclosures to prevent refrigerant theft.

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.

5. Management, Operation & Maintenance

Not a specification!

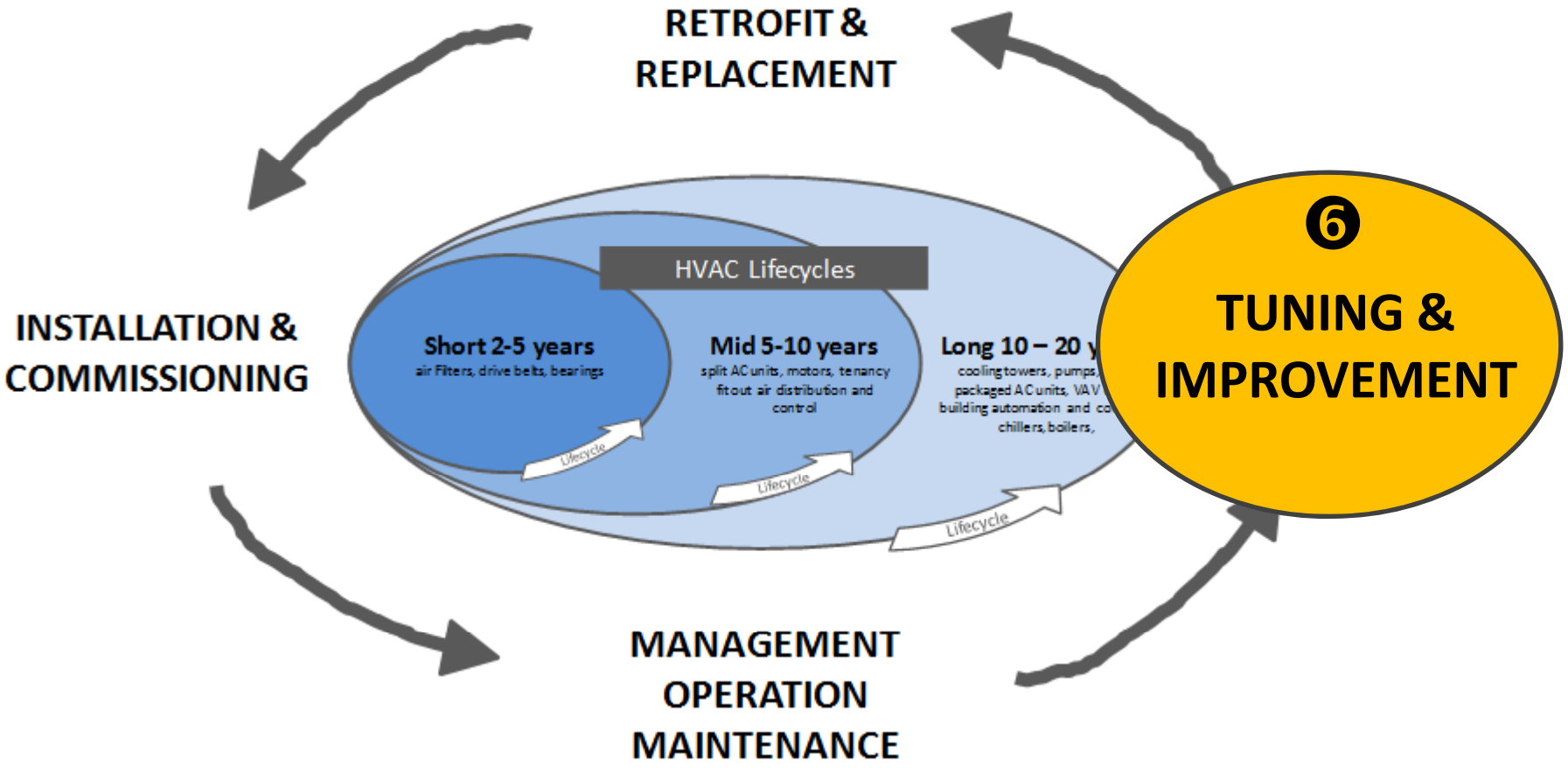


Management & operation…

Calculating Cool HVAC Rating Tool

coming soon…..

PART 6. Tuning & Improvement

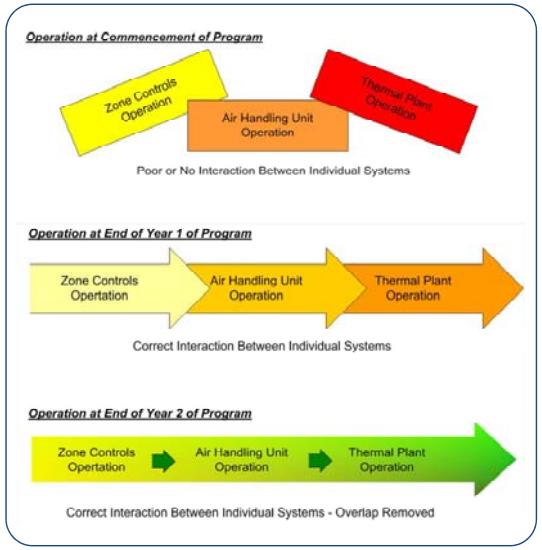


6. Tuning & Improvement

What's to be Had?

- Improved Star ratings (0.5 +)
- Energy and water cost savings
- Improved system performance
- Increased Asset life
- Knowledge of system
- Very good ROI

6. Tuning & Improvement



What is tuning?

- Planned process for improvement of building systems
- Use of BMCS to ensure energy consuming systems and plant are operating in ‘concert’
- Seasonal; plans and actions
- BMCS ‘tunability’

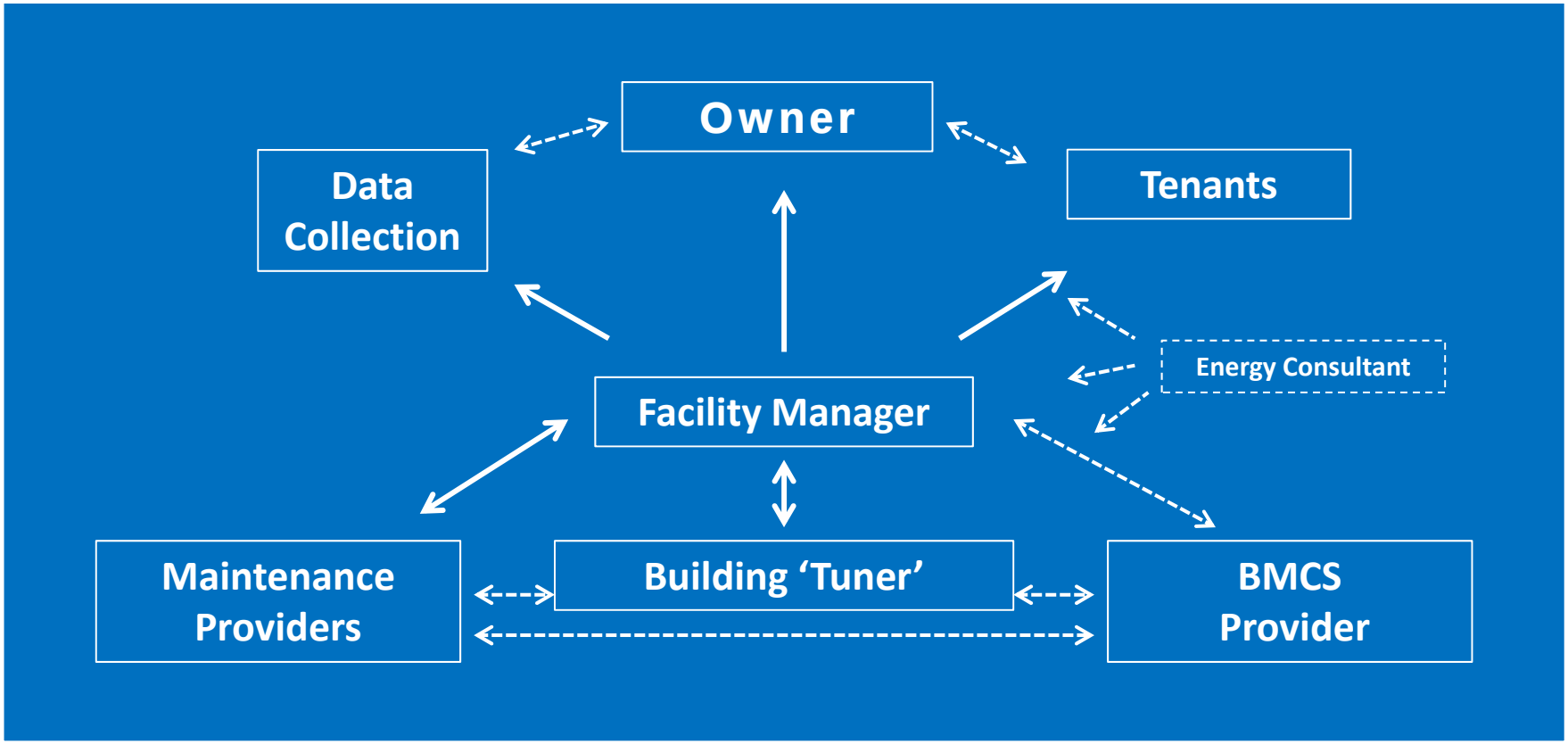
6. Tuning & Improvement

- Need people who understand how:
  - HVAC works, and how it consumes energy
  - BMCS works to code level to drive HVAC
- Regular involvement and intervention/ rectification – assurance of change
- Records keeping and learning
- Coordinated across stakeholders
- Reporting and communications

What is it not?

6. Tuning & Improvement

Stakeholders



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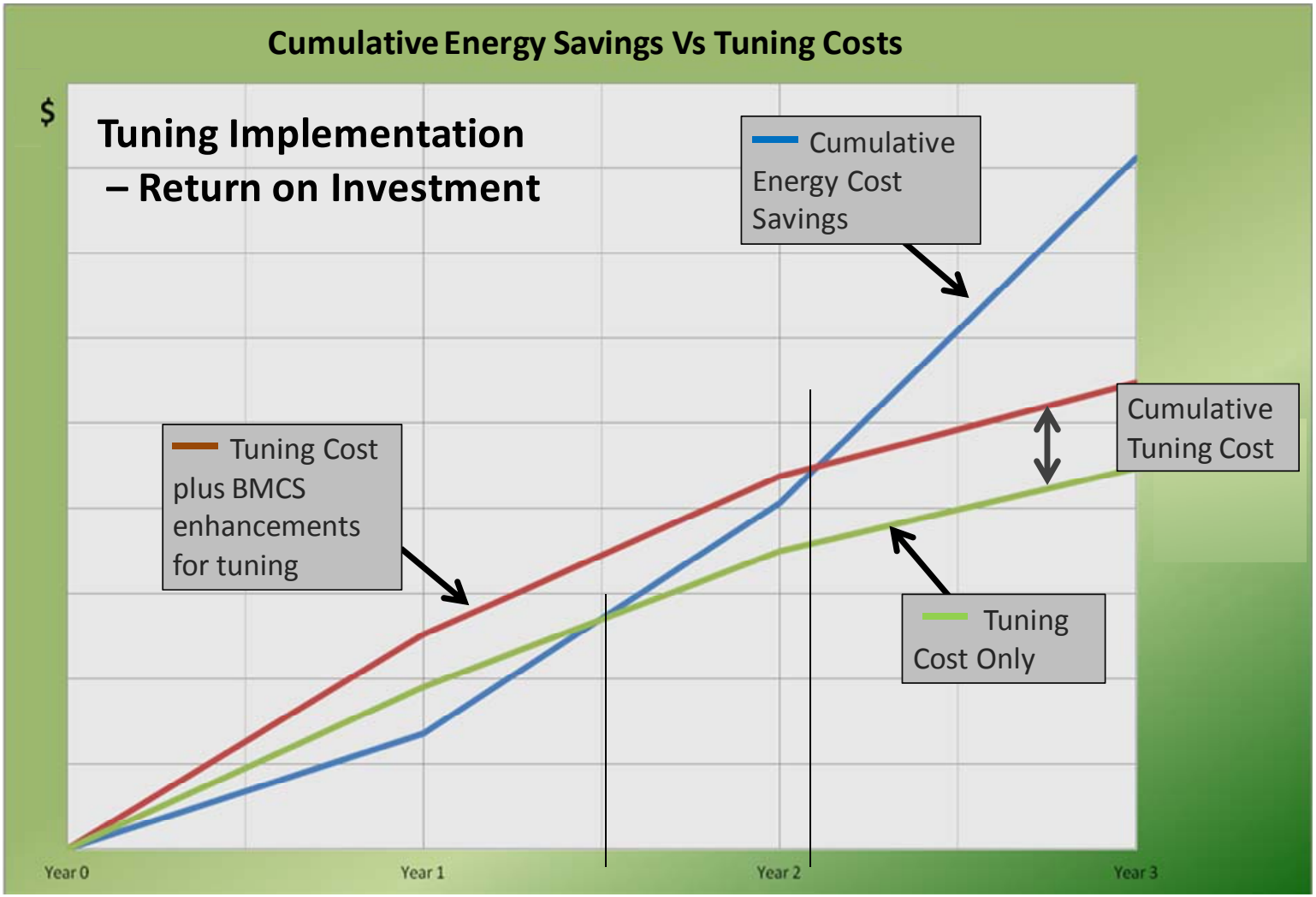


How tuning can lead to big performance gains in old buildings

Many people hear “retrofit” as a big rip-and-replace operation, but you don’t need to replace all your existing building systems to achieve substantial energy savings. With landlords on a quest to attract tenants in an environment where “green is good”, being able to tune older buildings for substantial energy savings and improved performance is a big win.

Buildings with higher NABERS ratings attract a premium and are sought after by tenants committed to basing themselves in 4.5- and 5-star premises. In an exemplar project in North Sydney, A.G. Coombs moved a building from a 2.5-star NABERS rating to 5 stars – with no new equipment.

With advances in technology and knowledge in the last 5-10 years, these results are possible for older buildings. An essential first step is an audit of a building’s existing performance. Ideally a minimum of 3-9 months’ data, including a summer, winter and a shoulder season, provide a basis for analysing current performance and understanding trends. Armed with this knowledge and a detailed understanding of the building’s current plant, equipment and control systems, a building tuning strategy can be developed.

This may include simple changes such as making a building’s morning start-up time later, or more complex programming changes to take into account dynamic parameters such as building load and ambient conditions.

Today’s technologies allow strategies to be tested in a proof of concept phase, where some manual programming of the building’s systems allows monitoring of changes to prove their effectiveness before building control systems are reprogrammed. A proof of concept also provides data to build a business case for the changes, with a clear understanding of costs, benefits and time to return on investment.

ROI can be rapid, and recent experience tuning a portfolio of buildings in the Melbourne CBD shows payback can be achieved in timeframes as short as nine months.

It’s not only technology advances that help us achieve better building performance. The industry is learning all the time, and strategies developed in the last 5-10 years can be applied even to older building stock.

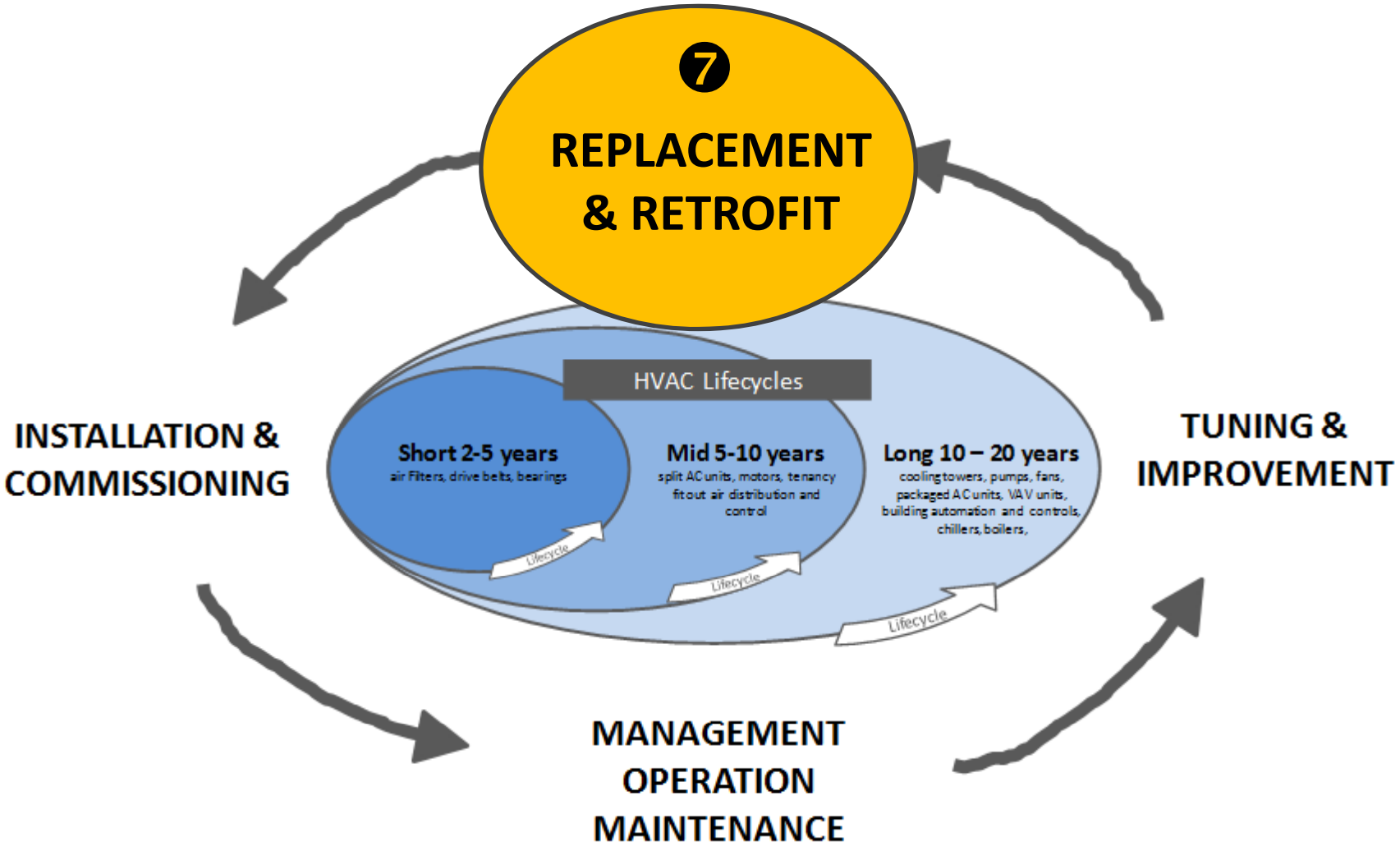
As long as the building owner and building manager are on board, you can take a look at what can be done even with 20-year-old buildings. It’s possible to achieve 25-50 per cent performance improvement from tuning alone. Performance improvements cover not just hard savings in energy costs, but also softer savings such as improved occupant comfort.

For the majority of buildings, hard energy savings deliver payback in something over 18-24 months, depending on the changes in strategy that are applied and the time taken for those to reach maximum effect. But the maths stacks up also in lengthening building equipments’ useful life and potentially improving rent/lease outcomes.

Tuning the buildings existing energy consuming systems to be the best they can be is the best first investment you can make in lifting your buildings environmental rating, extending the life of its plant and reducing your energy bills.

Source: The Fifth Estate . http://www.thefifthestate.com.au

PART 7. Replacement & Retrofit



7. Replacement and Retrofit

What's to be Had?

- Renewed asset
- Extended warranties on new equipment and reduced maintenance costs
- Improved building performance
- Step change ‘built in, improvement in energy efficiency and Star ratings (1.0 – 3.0 Star)
- Refrigerant phase out

7. Replacement and Retrofit

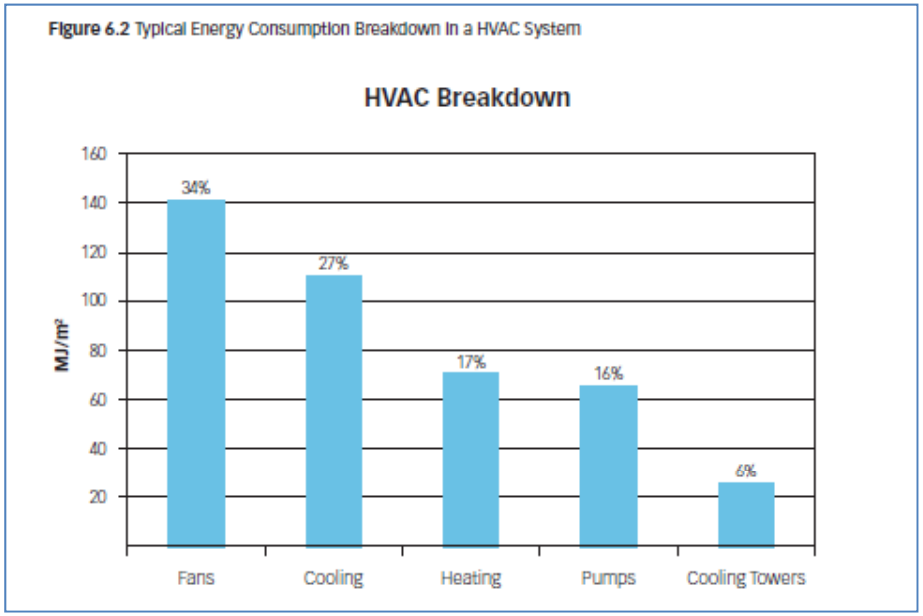
Key HVAC Issues

- Scope
- Stakeholders
- Technical
- Delivery Options
- Management

7. Replacement and Retrofit

Scope

- Central Plant, chillers, boilers, pumps, fans, filters, motors
- Air distribution
- BMCS
- Tuning
- Economies of Scale
- ‘Veracity’



Source Guide to Best Practice Maintenance & Operation of HVAC Systems for Energy Efficiency

7. Replacement and Retrofit

Retrofit – HVAC Stakeholders

STAKEHOLDER	EXPECTATION
Owner	• Green outcome • On-time, on-budget delivery • No tenant interruption
Tenant	• Similar comfort conditions • No disruption / inconvenience
Head Contractor / Builder	• On-time, on-budget delivery • Site approach ("what tenants?")
Facility Manager	• Usually controls works • No tenant complaints • Aging plant upgraded
HVAC Service Provider	• Existing contract commitments • New HVAC equipment scope?
HVAC Installer	• On-time, on-budget delivery • Performance outcomes

POTENTIAL CONFLICT

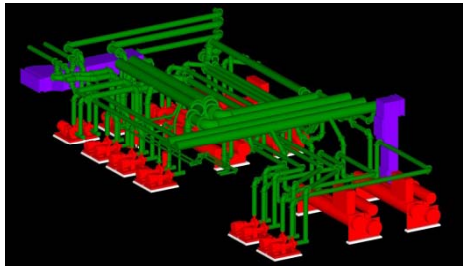
- **Limited understanding of green outcomes**
- **"Control" issues**
- **Existing building scope demarcation**

7. Replacement and Retrofit

Retrofit – HVAC Technical Issues

- **Mechanical**
  - Existing equipment condition – e.g. coils, corroded pipe
  - Interfacing with existing equipment
  - New technologies – e.g. chilled beam, displacement, cogeneration systems
  - Maintaining operations
  - Commissioning & Tuning
- **Electrical**
  - Staged power outages
  - Tenant vs. house supplies
  - Existing energy metering
- **BMCS**
  - Staged completion, network first
  - Managing old and new together
- **Fire**
  - ESM / BCA / AS1668 / AS1851
  - Stair pressurisation
- **Building Works**
  - Glazing specs
  - Hazardous materials
  - New structural penetrations
  - Dust
  - Access management

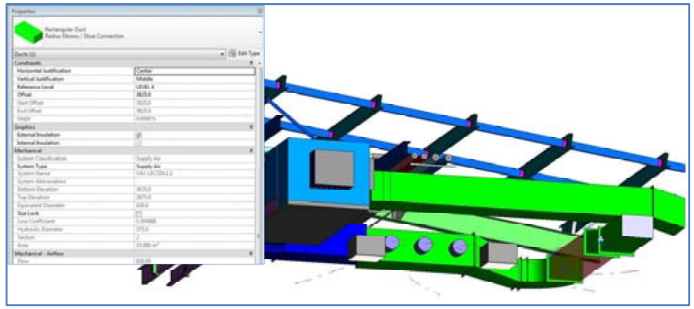
BIM and FM
Digitisation of the Built Environment



Now - design, equipment selection, plant and system operation, installation, commissioning records

Soon - BIM FM

- Compliance/attendance - *Proof*
- Maintenance schedule/ history/cost - *Planning*
- Access/safety/parts - *Preparation*
- Design/commissioning requirements – *Change*
- New and existing
- And much more



A Virtual system.....

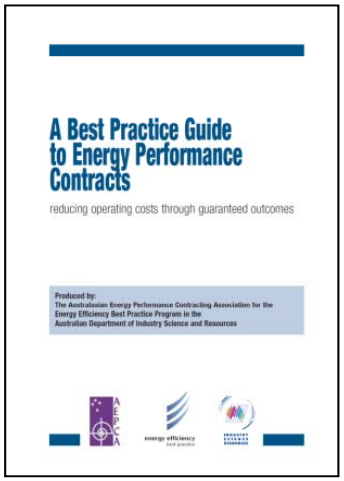
Building Information Modelling
Excerpt from A.G. Coombs Advisory Note

While Building Information Modelling is not new, the number of buildings being designed using BIM and the number of building developers specifying BIM models as an end deliverable has reached a critical mass in the Australian market. However, to obtain the full project benefits of BIM, including those of the closely linked Integrated Project Delivery (IPD) approach, requires industry based standards to be adopted.
Generally, BIM is defined as the process of generating and managing interrelated building information during its lifecycle. While most of the current BIM focus relates to its 3-D CAD capability, it is important to understand that the model contains more than just spatial information. In fact, BIM utilises a database of many design and build parameters such as capacities, acoustic performance and maintenance frequencies. This additional information provides the basis for using the model for a variety of purposes generally characterised into dimensions commonly referred to as follows:
4-D - Construction Programming (Time)
5-D - Estimates of Cost ($)
6-D - Environmental Assessment (CO2)
7-D - Asset Management (Building Life)
A fully integrated 7-D model is likely to be an aspiration for some time yet, but there are still immediate project benefits that can be obtained.
One of the most significant benefits is the use of BIM to enable the construction cost and time benefits of prefabrication that would otherwise be restricted by coordination limitations on site.
With the use of BIM to undertake early virtual coordination, this uncertainty is significantly reduced. Construction sequencing (4-D) can also be utilised to ensure that larger prefabricated modules can be positioned into place.
The other significant benefit provided by BIM is that design information can be retained and developed over the building life. For example, a fan capacity design value can be recorded and later compared to the selected fan's capacity and finally the actual commissioned fan output. This helps not only record the design intent, but also provides a benchmark against which the system can be maintained over the building's lifecycle.
This continuum of information can only be achieved where there is consistency of the modelling standards and protocols. Open standards limit the obstacles created by proprietary BIM's and unlock more long term benefits for the industry. To this affect, the Air Conditioning and Mechanical Contractors Association (AMCA) has developed a BIM Services Modelling Standard to facilitate collaborative design and fabrication as well as enabling improved supply chain integration. This non-proprietary standard, named BIM-MEPAUS, was launched in 2011 with subsequent releases of the standards issued in 2012. The objectives of BIM-MEPAUS are to:
Develop industry standards around BIM modelling
Reduce design and construction risks and associated costs
to industry stakeholders
Lower project costs.
The ultimate benefit of BIM for the client will be improved facility and maintenance management systems which support sustained long term building performance and the discharge of obligations in relation to statutory maintenance.

7. Replacement and Retrofit

Retrofit – Delivery Options

- What's involved, what skills are needed?
  Project Manager, Quantity Surveyor, Architect, Services Designer(s), Energy Modeller, Builder, Contractors, Sub Contractors, Suppliers?
- Experience with similar projects important
  Existing buildings different to new
- Energy Performance Contracts
  Energy Efficiency Council



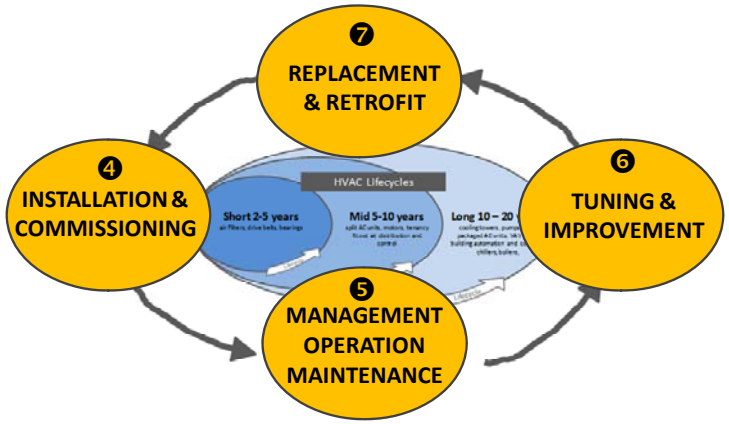
7. Replacement and Retrofit

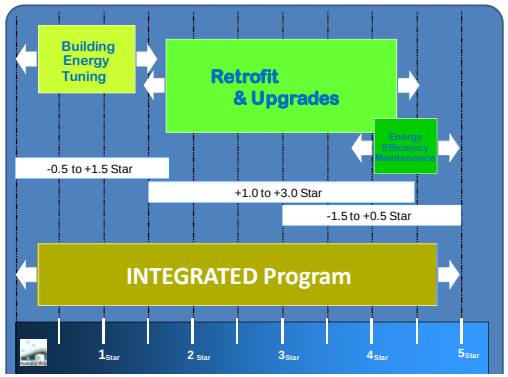
Retrofit – Management

- Project Management
  - *time/cost/quality and performance*
- Maintaining Tenant Services / Lease
- Competing Stakeholder Issues
- Compliance
- Access Management
- Staged Completion – Handover
- Records keeping and Documentation
- Communications skills

Seminar 2 – Recap

HVAC Management; Improvement Opportunities





4. Installation & Commissioning

- Correct operation
- Complete documentation and information to support efficient operation
- Getting what you paid for
- Foundation for improvement

5. Management, Operation & Maintenance

- Less tenant complaints
- Legal Compliance
- Retained Star ratings
- Reduced overall costs

6. Tuning & Improvement

- Improved Star ratings
- Energy and water cost savings
- Improved system performance
- Increased Asset life
- Knowledge of system

7. Replacement & Retrofit

- Renewed asset
- Step change 'built in, improvement in energy efficiency and Star ratings
- Improved building performance
- Extended warranties on new equipment and reduced maintenance costs

References

- **City of Melbourne**

  -1200 Buildings Website

- **AIRAH**

  - Air Conditioning 101, DA's

- **Your Building /Property Council**

  - *Existing Building Survival Strategies*

- **FMA**

  -Tools for Change

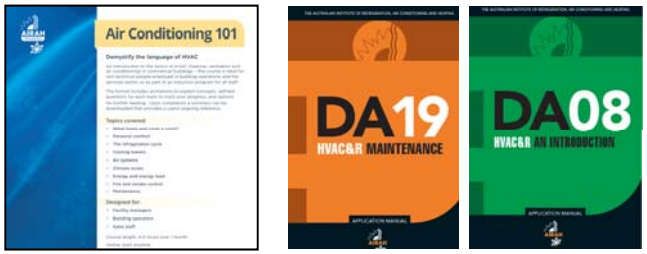
  - Sustainable FM Operations

- **HVAC HESS**

  - Best Practice Management & Maintenance HVAC Systems for Energy Efficiency

- **Energy Efficiency Council**

  - Best Practice Guide to EPC's



BLOWING HOT AND COLD

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

Seminar 2: HVAC Management and Improvement Opportunities

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

AIRAH

CITY OF MELBOURNE