

# Maintenance for Energy Efficiency and Ongoing HVAC System Tuning

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## Synopsis

*This paper recognises the drivers and trends in the broader property industry that are demanding energy efficient maintenance and ongoing tuning for HVAC systems to improve their energy efficiency. The current HVAC maintenance paradigm is reviewed together with general maintenance practices and a series of issues and challenges are identified. Energy efficient maintenance is defined in terms of focus, scope, cost and benefits. The paper offers a way forward and suggested actions to encourage the development and promulgation of energy efficient HVAC maintenance practices through the industry.*

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The need to improve the energy efficiency of existing buildings and maintain the efficiency of new green buildings whilst self evident is only now becoming a focus for the broader property industry. Until recently attention has been largely on the design and creation of new green buildings. Star rating systems are helping to drive this change. Awareness of the difficulties in achieving or improving and then keeping an annually assessed operational Star rating are becoming known to a larger group.

New and alternative building delivery approaches requiring long term measured performance outcomes such as Public Private Partnerships are further promoting the need for continuing energy efficiency as is the sustainability commitments of a new breed of corporate owners and tenants. In this the role that maintenance and tuning plays in reducing the amount of energy a building consumes and keeping it efficient is also becoming apparent to the broader industry and will become more so. The demand for energy efficient HVAC maintenance and system tuning will increase dramatically in the next few years. The opportunity exists to be proactive and put in place actions to increase the rate at which these improved practices are developed and implemented.

## Current Practice

The current overarching rationale for maintaining HVAC plant is the requirement to provide acceptable and reliable internal conditions, behind that there is a need for demonstrating legislative compliance and an underlying requirement to preserve asset condition. Current practice is not generally about doing all of this whilst ensuring the systems operate efficiently. As such the great majority of HVAC maintenance fits into a standardised and scheduled 'minimalist' approach. It is 'one size fits all' with little tailoring to any particular requirements and it is predominantly done with a focus on individual items of plant and equipment rather than whole systems.

It is driven by scheduled attendance and there is little penetration into the HVAC maintenance industry of condition based maintenance approaches. The introduction of legislation relating to essential safety measures and Legionella risk in recent years has had the positive effect of introducing an element of compliance into HVAC maintenance however it has also further contributed to the 'scheduling' of maintenance.

The focus on attendance and increasingly on compliance sees the industry predominantly cost rather than quality driven. There is an absence of any commonly applied quality measures like energy monitoring. The focus on cost and lack of quality drivers also means that the technical and management skill base has become diluted.

When building tuning or recommissioning is considered it is usually assessed as a distinct project and approached in the same way that new systems would be commissioned. As such is very expensive and rarely carried out. More often than not poorly performing systems are tolerated until other circumstances initiate a refurbishment and sometimes additional thermal capacity is installed to accommodate wastage in poorly tuned systems.

The maintenance industry also is responsible for a large amount of equipment replacement and this is usually carried out on a like for like least cost option basis with little or no consideration of any broader issues.

## **Issues and Challenges for Change**

The most significant issue inhibiting the development and take up of energy efficient maintenance to date has been the low level of demand from the property industry, given that this is changing there remain a number of issues and challenges to the widespread implementation of energy efficient maintenance.

- There is a lack of a clear and agreed definition as to what it is. The concept of maintaining plant for energy efficiency is known but not widely understood. Whilst there is a wide range of references and standards relating to HVAC maintenance and a lesser number relating specifically to energy efficient maintenance none of these provide clear, complete and concise guidance that is appropriate to the emerging need.
- There is not a widespread understanding of how energy is consumed in HVAC systems and how to go about minimising that through appropriate maintenance and ongoing tuning processes. There are also a number of skill gaps in the industry particularly around building controls and building automation systems. The advent of DDC has seen dilution in the understanding of controls technicians in the operation of the HVAC devices and systems driven by their technology, and the controls systems themselves have become too complex for maintenance technicians to understand.
- There generally are not the mechanisms in the market to monitor and assess the quality of the maintenance offering and the resulting value for money equation. Maintenance has become an attendance and compliance issue with little management structure either from the client organisation or the service provider.
- As a result of industry trends for property management and outsourcing few client organisations have technical people managing maintenance contracts. There are few consultants providing support in this field compared with 15 to 20 years ago. To a large extent the scope of HVAC maintenance is determined by the service provider either through their standard schedules or their interpretation of standard maintenance specifications.
- In response to price pressures many maintenance organisations have chosen to reduce or even eliminate the supervisory level in their business and leave the responsibility for this to the maintenance technicians themselves.
- Building system tuning is seen as a separate exercise to maintenance and consequently rarely carried out.
- It is only in relatively recent times that formal dedicated training courses have been developed for HVAC maintenance technicians and the training infrastructure in this area is in its early days and far from consistent throughout Australia. There is some specific energy efficient maintenance training offered however it is not mainstream.
- The current industry paradigm of how HVAC maintenance is budgeted, specified, priced, contracted, performed, reported on, managed and commercially profited from has developed over some time, and is firmly fixed in place. It will not be easy to change.

## **What is Energy Efficient Maintenance?**

Energy efficient maintenance is nothing new however it is significantly different in most cases from the current standard practice in the Australian HVAC industry. It is:

- **Building specific and system focused.** Every building, its operational requirements and importantly its HVAC systems is different from the next. As such to ensure that it is efficient requires a specific approach that reflects the buildings particular circumstance. HVAC systems are just that, systems, whilst it is important to ensure individual items of plant are efficient the potential for greatest waste in HVAC is when systems operate out of sync or even worse, fight each other. A systems approach to maintenance is essential to achieve energy efficiency.
- **About Internal conditions, reliability and efficiency!** This requires a shift in mindset from maintenance specifiers, maintenance managers and most importantly maintenance service providers.
- **A structured process** and has a number of elements with additional and different scope to current normal industry practices. The elements include:

*Management, Monitoring and Reporting* processes that provide a cohesive framework to ensure the activities are appropriate, are carried out and improvements are achieved.

A *Maintenance Regime* that is structured and documented. It needs to be building specific. It needs to address energy waste specific items and include systems specific regimes. In addition to preventative activities it must include inspection and testing activities along with checking and calibration regimes. Maintenance specifications should be instructional in their approach and detail. They should include instructions specifying how particular systems should be tested, checked and calibrated (See example) and technicians should be required to record what was carried out and the results of checking, testing and calibrating.

**Technician Instructions - Outside Air Thermostat**

-set temperature set point at minimum  
-measure outside air temperature at sensor  
-slowly turn set point dial up and record from dial the temperature at which the thermostat switch 'breaks'  
-slowly turn the set point dial down and record from the dial the temperature at which the thermostat switch 'makes'  
-if the temperature differential (difference between make and break) is more than 2°C then adjust thermostat internal differential set point to minimum and repeat test - noting result on test record sheet  
-if the thermostat is properly calibrated then the thermostat should break at the measured outside air temperature plus 1°C. If this is not the case then apply a label to the thermostat noting the offset between actual and displayed  
-set temperature set point at maximum and complete other tests

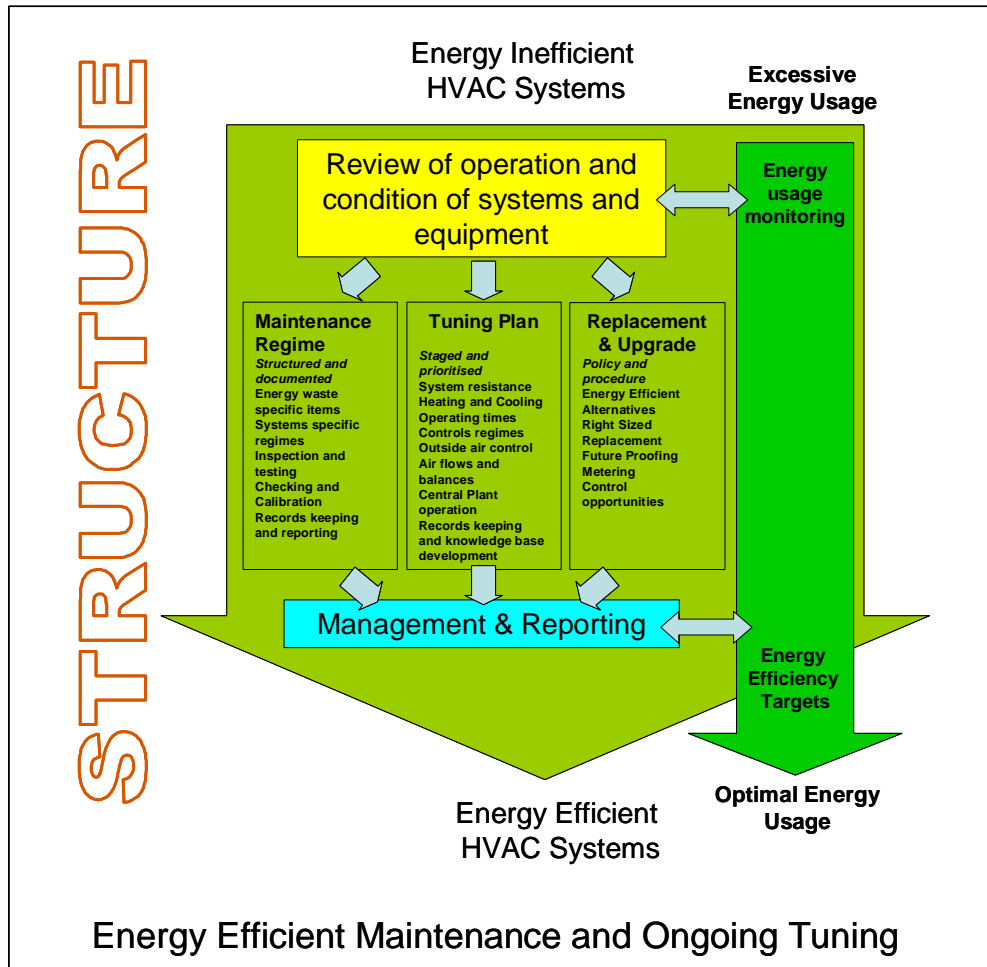
Source: Ref. 9

*Ongoing Tuning* should be incorporated into the broader maintenance and operational process and should be a staged and iterative process of elimination of waste and improvement of efficiency. Primary areas of focus should include system resistance, heating fighting cooling, operating schedules, controls regimes, outside air control, air flows and balances, and Central Plant operation. It is essential for any iterative process like tuning that records keeping processes and disciplines be put in place and adhered to in order to document cause and effect and support improvement.

*Replacement & Upgrade* policies and procedures need to include for an assessment stage and ideally preplanning for items of plant or equipment that will require replacement. In many instances economics preclude the replacement of items solely on an energy efficiency basis however failure or the end of economic or functional life often offers the opportunity for cost effective improvement and this opportunity should be considered as a matter of course instead of an automatic 'like for like' replacement. Aspects to consider include; energy efficient alternatives, right sized replacement, future proofing against envisaged changes in requirements, incorporation of end use energy metering and opportunities for improved control and or operational regimes.

- **Same skills, different focus.** Energy efficient maintenance requires the same skills that are currently available in the industry, although in somewhat short supply. However it needs a change in focus and attitude to bring those skills to bear with a different approach and it is more demanding for skill at every level.
- **More costly (usually).** Maintenance that pays some attention to the energy efficiency of HVAC systems does not have to be more costly than current activities providing there is a refocusing of effort and rearrangement of scope. However if it is to be carried out in a structured way to assist in meeting demonstrated and measured outcomes such as achieving a building Star rating it will almost inevitably cost more than current normal maintenance practices. If a better outcome is required there must be a commitment to better management and practices. The key is to see this as an investment from which there is expected a return, a return that is to be measured and monitored. Various studies have indicated that the costs associated with improved maintenance practices are recouped in energy cost savings (Ref. 8)

- **Better maintenance** that will offer a number of significant benefits additional to energy efficiency. Better maintained systems will be more reliable and perform better; this will result in fewer occupant complaints and problems. HVAC systems will have longer functional and economic lives; this has both financial and environmental benefits. And these systems, and the buildings they serve, will be safer.



### The Way Forward?

Larger issues are inexorably driving the demand for significant improvements in the energy efficiency of Australian buildings and the requirement for energy efficient HVAC maintenance and system tuning will increase dramatically in the next few years. Going forward there is opportunity in a number of areas to be proactive and put in place actions to increase the rate at which these improved practices are developed and implemented.

- **Definition:** What energy efficient maintenance is should be further defined and clearly communicated to the stakeholders in the process. These include building owners and managers and importantly maintenance providers themselves. There is the need to develop a clear and concise Australian guideline in this area that should become the industry standard. It should incorporate an integrated and ongoing tuning approach. Once defined awareness must be raised and complimentary training put in place to promulgate the practices and raise the skill level in this area.
- **Demand:** The demand for energy efficient maintenance must be increased. The best mechanism for achieving this will be by strongly promoting the understanding that the achievement of annually audited operational Star ratings is reliant in good part on effective HVAC maintenance and ongoing tuning. Whilst there are organisations that are exceptions, the maintenance service provider industry is largely reactive, in the past the industry has generally not provided enhanced services without demand from its clients or legislation.

Building owners and their delegated managers must challenge the industry to improve its product through improved specifications and the requirement for demonstrable outcomes.

- **Management:** Increased demand for better outcomes should be accompanied by the understanding that a more sophisticated management model is required to achieve the desired outcome. The requirement for better maintenance management should be promoted to building owners, tenants and building managers and should result in enhanced specifications, increased levels of supervision and assessment and more detailed reporting. This new approach must also include an equitable distribution of responsibility to appropriate parties and a recognition that all elements of the industry are on a development path.
- **Framework:** The need for a broader Energy Management Framework should continue to be promoted. Ultimately a structured program that addresses all areas that impact on energy efficiency and energy consumption driven by senior corporate objectives and metering, monitoring and reporting regimes is required to achieve lasting strategic energy efficiency outcomes.

External factors are demanding significant reductions in the energy consumption of our buildings and the role that HVAC maintenance and tuning has in achieving this objective will become widely appreciated and understood. In this the future is clear and with this foreknowledge there are opportunities to be proactive and be better prepared to meet the coming demand for improved maintenance practices and outcomes.

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**About the Author:**

Bryon Price is a Mechanical Engineer with notable experience in energy efficient buildings. He is Business Development Director for the A.G.Coombs Group of companies. Prior to joining A.G.Coombs Bryon was responsible for a range of energy and environmental projects. These included long term energy management roles with a number of major financial, commercial and retail organisations, and various Commonwealth and State Government Departments, and the preparation and management of a number of innovative energy and environmental performance briefs for major building developments. Out of this experience his particular area of knowledge and interest is “whole of life” energy and environmental management in buildings.

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