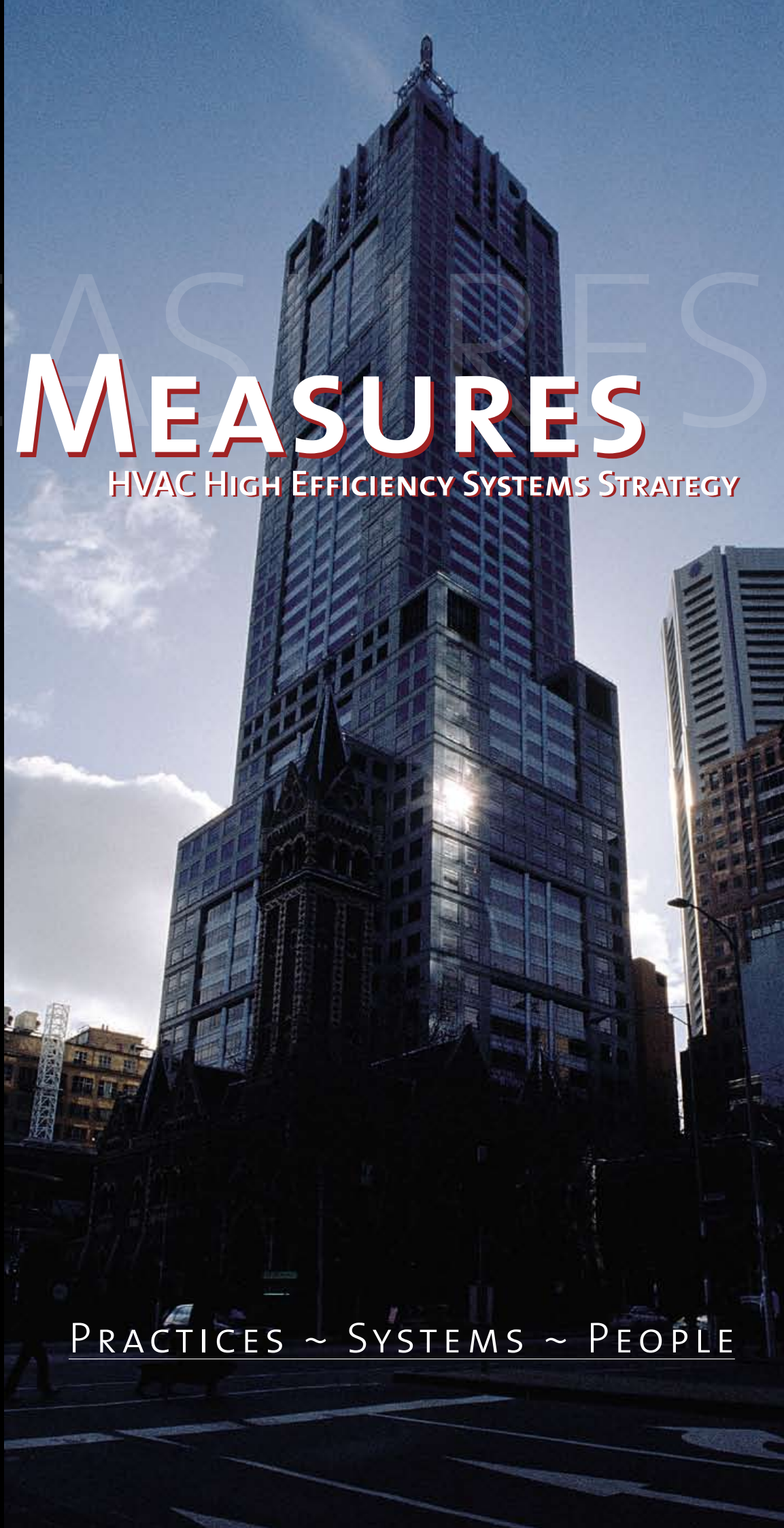
The Measures

HVAC High Efficiency Systems Strategy

Heating
Ventilation
Air-Conditioning
& Efficiency

For the
Equipment Energy
Efficiency Commitee



Practices ~ Systems ~ People

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This paper has been prepared for the Equipment Energy Efficiency Committee under the auspices of the Australian and New Zealand Ministerial Council for Energy.

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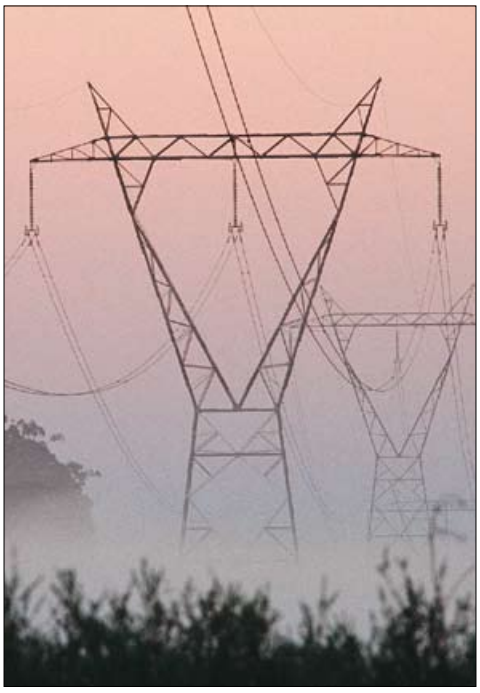
Practices ~ Systems ~ People



"If the objectives of the HVAC High Efficiency Systems Strategy are achieved it will deliver annual greenhouse emissions reductions of as much as 4 million tonnes and energy cost savings of around $350 million per annum."

Introduction

When the HVAC High Efficiency Systems Strategy was first started, a leading industry figure told the writer that, "HVAC systems and energy efficiency are mutually exclusive." This was said with some irony because many industry participants are committed to designing and delivering efficient systems.

Both the market for HVAC services, and the process of designing, delivering and operating HVAC systems have, in the past, failed to create the conditions that ensures efficiency throughout the life of systems. Some improvements in market behaviour in recent years has created better market conditions, in some sectors, that support improved efficiency. Many aspects of the industry processes are still failing. This project attends largely to the failures in the industry processes.

The range of measures proposed herein to improve the energy performance of HVAC systems is the outcome of an extensive consulting process. Between July 2005 and December 2006, hundreds of participants along the supply chain for HVAC systems were emailed with discussion papers, interviewed face-to-face, engaged in debate at seminars and presented with proposals at conferences. More than 50 written responses from industry members were received and many more emails, phone calls and conversations provided comment, suggestions, links to other studies, reports and programs.

The project involved the publication of two lengthy discussion papers (September 2005 and May 2006) which were then presented and discussed at a series of industry forums and seminars and used as a focal point for discussion and debate. These was followed by three draft strategy papers in August, October and December 2006 all of which were circulated for further comments, additional ideas and refinements to the actions proposed.

The consulting process confirmed that the industry are aware that, and agree that, the majority of HVAC systems run far from optimally in energy terms. Even the performance of systems in new buildings, designed with energy efficient outcomes in mind, are often found to be running relatively poorly within a year or two of commissioning.

The technology of HVAC is capable of high levels of efficiency, however optimal performance cannot be achieved with a 'plug and play' approach. The systems are complex and almost every building or situation has unique factors.

To achieve optimal performance of systems requires quality control from design to commissioning, intelligent operation and complete well documented maintenance.

This can be delivered with a cohesive, national and industry wide approach, attending to failures of process, lack of skills and practical knowledge of systems optimisation and operation along the supply chain.

A significant number of initiatives to address aspects of this situation have been commenced by different parties and in various jurisdictions in the last two years. The HVAC High Efficiency Systems Strategy would aim to leverage of and compliment other efforts and aim to provide management, support and materials suitable for a national, co-ordinated effort to achieve shared objectives.

Executive Summary

The installed base of non–residential HVAC systems in Australia are estimated to:

- Consume 9% of electricity produced in Australia and produce more than 3.6% of the total Australian greenhouse gas inventory (>21Mt CO_2 pa);
- Depending on the building type and use, be responsible for between 40% and 60% of all energy used in non-residential buildings;
- On average create more than 55% of electrical demand recorded in CBD buildings during peak demand periods;
- Involve cooling towers that consume billions of litres of water per annum across Australia;
- Service approximately 120 million m^2 of buildings, are part of an industry worth about $7 billion per annum and employing at least 95,000 people.

A ten year strategy designed to improve the energy performance of HVAC systems was commissioned by the Equipment Energy Efficiency committee.

The resulting strategy has received widespread industry and stakeholder endorsement and has a target of improving the energy efficiency of the installed base of systems by 20% over the life of the strategy. If that target is achieved it would reduce greenhouse gas emissions by approximately 4Mt pa and save as much as $350 million in energy costs pa.

The strategy that has been designed addresses many non-technical barriers to efficiency while identifying and promoting highly efficient technical solutions, systems optimisation processes and creating the environment in which energy efficiency gains are valued, measurable and sustainable.

More than 20 separate but complimentary measures are proposed across eight priority areas, grouped under three broad strategic initiatives

~ Practices, Systems, and People.

Practices – creating nationally standard cradle-to-grave systems of documentation and data capture that allow trained climate control professionals to most effectively commission operate, and maintain the performance of HVAC systems.

Systems – Identifying, demonstrating, analysing and promoting best practice, sustainable efficiency gains and technological advances, systems and tools across the entire spectrum of climate control industry participants and stakeholders.

People – creating nationally standard, recognised and transferable qualifications and certificates built on effective mulit-disciplinary training modules that provide numerous entry points for industry participants and stakeholders to access material that improves their understanding of HVAC systems and their skills as climate control professionals.

NEMMCO power control centre, eastern and southern Australia

Initiative 1 - Practices

Codes of Best Practice, Documentation Standards and Shared Incentives

Creating complimentary codes of practice along the supply chain
Creating full life cycle systems of documentation
Creating tools and systems for operational data capture and shared access reporting
Give trained operators and practitioners the information and tools they need to optimise any system in any situation.

Priority 1
Installation, Commissioning and Maintenance Best Practice

Objectives

Improve standards of installation and ensure accurate documentation of 'as-installed' systems. Develop information tools and codes of best practice for Climate Control professionals, develop best practice commissioning process and make them central to effective building or system completion and achievement of building performance rating.

Develop codes of best practices and tools to assist climate control professionals to save energy, take effective control and extend the life of systems. Develop and promote best practice maintenance contract specification. Create tools that co-ordinate operation and maintenance practices, and operational and maintenance information capture. The Code of Best Practice for Maintenance forms a central part of the process for fulfilling the requirements of the Building Log Book.

Obstacles

Installation of systems is often not overseen by personnel who understand the original design intent or critical factors in achieving optimal performance. Systems are often not well documented as installed.

Insufficient time and resources are allocated to enable commissioning engineers to properly commission and handover new and refurbished systems, or to have reasonable involvement in advising or inspecting design and installation. Building design and completion often do not allow or leave suitable access for proper inspection, commissioning or maintenance.

Effective documentation of systems from design, through installation to commissioning are generally not available providing no basis for good long term maintenance programs or for long term monitoring and analysis of comparative performance as building uses change and systems are upgraded or changed.

Other than in Health Facilities and in some public sector facilities there is little enforcement of, or compliance with, regulatory or legal requirements to complete maintenance regimes for HVAC systems. Systems can operate for decades without routine or effective maintenance. Existing standards set out cleaning and inspection regimes that are widely regarded as unachievable, impractical, unnecessary or uneconomic. As common practice has become established that does not comply with standards the value of standards overall is undermined.

Operators of HVAC systems often do not possess a high level of comprehension of the systems they operate and the controls they have available to them, sufficiently to comprehend the relevance of observed changes in performance or energy consumption, and to draw correct conclusions or base effective management decisions on the information available.

Maintenance contractors and personnel may have a higher level of understanding of systems and controls, but are often unaware of operating characteristics of systems and the buildings in which they are operating and do not often benefit from meaningful daily operational observations or management data.

I1 P1 Response 1
Scheme of Best Practice for HVAC System Installation and Commissioning

Develop an Australian scheme of best practice for installation and commissioning of HVAC systems. The Code of Best Practice for Installation and Commissioning is the cornerstone of the process for fulfilling the requirements of the Chain of Custody Documentation for buildings and systems.

Target
Completion of Scheme of Best Practice for Installation and Commissioning 12 to 18 months after commencement of strategy.

I1 P1 Response 2
Code of Best Practice for Maintenance of HVAC Systems

Develop and promote an Australian scheme of best practice for maintenance of HVAC systems, including contract specifications and pro-forma contracts.

Target
Completion of Scheme of Best Practice for Maintenance 12 to 18 months after commencement of strategy.

I1 P1 Response 3

Establish practical nationally uniform standards for inspection, maintenance and documentation

Engage with government and industry leaders to review standards and regulations to design an affordable, effective and practical, nationally consistent regimen of inspection, cleaning and documentation of the state of HVAC Systems.

I1 P1 Response 4

Clean Efficiency Program_

With particular attention to all heat exchange surfaces develop materials and a campaign promoting the easy energy savings available from effective cleaning and protection of heat exchange surfaces. Arrange delivery of a short course for building services contractors to update them on latest procedures for inspection and cleaning heat transfer services including use of latest safe and non-corrosive cleaning agents as well as products and services to assist in maintaining the efficiency of the heat transfer surfaces. The courses will include training in the recording of HVAC system condition, remedial action and completion of other documentation required by the HVAC HESS. Where possible document findings and resulting system performance improvements and cost savings.

Target

Launch Clean Efficiency Program within 6 to 8 months of commencement of strategy including case studies demonstrating savings captured through long overdue cleaning of heat exchange surfaces and a simple "ready reckoner" to allow stakeholders to calculate potential energy waste and cash savings from a Clean Efficiency check up.

Expected Outcomes

Best Practice Installation and Commissioning Certification for Climate Control professionals following training and/or demonstration of competency.

The involvement of expert commissioning practitioners in the early stages of design, manufacture and installation of HVAC systems and then best practice commissioning of those systems will form the cornerstone of well documented systems that will deliver a lifetime of high efficiency HVAC services

Maintenance of HVAC systems will become a routine and well understood process contributing directly to the positive economic performance of buildings by reducing operating costs, increasing reliability and improving returns on capital investment in HVAC systems. Facilities managers and building services contractors will become more highly trained in understanding operation and maintenance aspects of systems and building performance and being able to interpret and benefit from comprehensive system documentation.

For systems whose heat transfer surfaces have not been inspected and cleaned in the last three years an immediate energy saving of at least 10% is expected to be achieved following cleaning (case studies have demonstrated much greater savings in many instances). Inspection and documentation of systems by building services contractors when cleaning surfaces will form part of the basis for building owners to develop best practice documentation.

Priority 2
Building Log Book and System Documentation Standards

Objectives
Comprehensive building mechanical service documentation and on site or electronic Log Book providing constant access to critical shared information by all technical stakeholders and providing a framework for capture of operational data and observed performance. The Log Book forms the cornerstone for a building's Chain of Custody Documentation System capturing complete life cycle system information from concept to decommissioning.

Obstacles
Operation, maintenance and facilities management personnel and contractors change frequently. Operation and Maintenance records, and records of system performance and routine observations of system and building performance under different climatic and seasonal conditions, if documented at all, is often poorly documented. Building and HVAC system documentation and component specifications is generally found to be insufficient or too inaccurate to provide a detailed record of all of the elements of a system 'as installed', commissioned, operated, altered or repaired and maintained.

I1 P2-Response 1:
Australian Building Log Book

Develop a Building Log Book for Australian conditions that allows for the actual and/or virtual storage and capture of all System Performance, Operation and Maintenance data, processes, reports and plans and for data capture and comparison over time on a number of metrics.

The Building Log Book could be electronic and accessible by secure web based browser systems to allow shared access by appropriately cleared personnel to historical, operational and live data.

I1 P2-Response 2:
Chain of Custody Documentation

Develop a template for a Chain of Custody Documentation Standard for HVAC systems, from design to decommissioning, that captures every aspect of the development, construction, commissioning, operation and maintenance of a system making it simple to identify all components, service providers, maintenance routines, capital, operating and maintenance costs and operational performance of HVAC systems. Produce all documentation templates and training material in electronic formats for distribution by electronic media and establish a process for updating and promotion of that material.

I1 P2-Response 3:
Incentives and Compliance

Seek to establish maintenance of Building Log Books and minimum commitments towards development of Chain of Custody documentation as a prerequisite for achieving and retaining building performance ratings.

Expected Outcomes
Participants at all stages of the supply chain for HVAC systems will become accustomed to expect a standard of documentation that allows easy reference and common access on all aspects of a system design, specification, installation, and operation.

Climate Control professionals and system users will assist fill in documentation gaps over time for existing systems. System suppliers and owners will come to expect comprehensive documentation to be in place to assist with design reviews, refurbishment and maintenance contracts.

Priority 3
Promotion and Market Information, Finding Shared Incentives

Objectives
Identify and promote the benefits to building owners and operators the benefits of adoption of Codes of Best Practice and engagement with the measures in the HVAC HESS.

Identify, demonstrate and promote means of creating shared incentives across all stakeholders in achieving highly efficient HVAC operations

Obstacles
In buildings not occupied by owners, it is often the case that capital and maintenance costs of HVAC equipment and systems is borne by building owners. Savings however often flow to tenants.

I1 P3 - Response 1:
Early Adopters Program

Promote and support professionals and businesses who demonstrate capacity to comply with and employ codes of Best Practice of Installation and Commissioning and Codes of Best Practice for Maintenance and Operation. Work with Government and industry stakeholders to get institutional and corporate sign on and adoption of the code.

I1 P3 - Response 2:
Incentives and Compliance

Work with Government and industry stakeholders to establish some economic incentive for best practice installation and commissioning. Establish regulatory and compliance requirements for best practice installation and commissioning, underpinned by effective codes that are practical and effective. Make compliance with the codes of best practice a condition of receiving and maintaining building performance ratings.

I1 P3 - Response 3:
Finding Shared Incentives

Design and demonstrate contractual arrangements allowing stakeholders to share the costs and risks of investment in new equipment and innovation while also sharing the benefits of improved controls, comfort conditions and energy cost savings.

I1 P4 - Response 4:
Efficiency Performance Bonuses and Awards

Work with stakeholders to establish practices and contracts that allow facilities managers and contractors to share and be acknowledged for energy savings captured for building owners or tenants in day-to-day operation.

Expected Outcomes

Certification of systems commissioned as per an Australian code of Best Practice will be valued by market leaders in both the Climate Control industry and among the industry clients who seek high building performance ratings and quality documentation of assets. Eventually commissioning according to the code will be required to achieve higher building performance rating levels. Successful economic and contractual models creating shared incentives for investments in energy efficiency, promotion of efficient behaviours and co-operative action and energy cost savings could become a significant feature of the non-residential buildings market.

Initiative 2 - Systems

Technology and Innovation
Making innovation accessible, acceptable and effective.

Priority 1
Monitoring and Metering – Climate Control Energy Ratings

Objective
Demonstrate the efficacy of sub-metering strategies of complex systems from practical control, management and economic points of view. Create tools and options for monitoring, metering, analysing, predicting and comparing HVAC system and component performance.

Obstacle
Meaningful comparative information about the performance of individual HVAC systems is not readily available in a form that is easily used by the entire market, from designers through to tenants and energy utilities.

I2 P1 - Response 1:
Climate Control Performance Measures

Develop a suite of Climate Control energy rating, metering and monitoring strategies that inform the owners, operators, service personnel and energy utilities about the energy performance, greenhouse characteristics, age and state of repair of HVAC systems.

I2 P1 - Response 2:
Metering Strategies Demonstration

Establish collaborative projects with building owners, utilities and Climate Control industry participants to refit select HVAC systems with sub metering systems and demonstrate use of the resulting data in HVAC control strategies and in reports regimes to building managers.

I2 P1 - Response 3:
Wireless Data Logging Demonstrations

Establish collaborative projects in older buildings to demonstrate system refits with low cost wireless data logging systems monitoring HVAC component performance, comfort conditions and air quality and demonstrate use of the resulting data in HVAC control strategies and in reports to building managers.

Expected Outcomes
Climate Control professionals and stakeholders will be given options and tools enabling them to understand, anticipate and measure the actual performance of existing HVAC systems based on commonly used measures of system performance. Improved understanding and observations of performance data will provide useful management information with implications for maintenance and refurbishment priorities and schedules, operating strategies and running costs of buildings, and provide information on component operation, age and state of repair.

Priority 2
Innovation and Technology

Obstacle
HVAC systems are already regarded as the element of construction programs that are most likely to deliver cost over runs or delays. Technological or system innovation adds an additional element of risk to HVAC systems from design through to commissioning.

Objective
Promote knowledge and experience of new products and practices, ensure promotion of cost effective and leading edge technology and innovation through case studies and existing industry media and forums

I2 P2 - Response 1:
Promote High Efficiency Systems and Innovation Case Studies

Actively seek out examples of cost effective innovation, new technology, systems and best practice in Australia and overseas and ensure promotion and rapid dissemination of quality information on these subjects using existing industry media. Seek opportunities to participate and promote utility/asset owner partnerships driving embedded generation coupled with absorption chiller systems and other novel Building Integrated Generation projects.

I2 P2 - Response 2:
Refurbishment Innovation and Case Studies

Building refurbishment programs often present more of an opportunity and more time to plan for and use innovative techniques and systems than higher risk new building programs do. Seek out partners planning building refurbishments and negotiate projects that result in use of innovative systems and components to deliver advanced HVAC systems, data gathering, reporting and control strategies into existing buildings. Support an industry award system for innovation and excellence.

I2 P2 - Response 3:
MEPS and Energy Labels

Support introduction of MEPS and energy labelling programs for components of HVAC systems that are not already covered and for which an economic case can be mounted.

Expected Outcomes

Promotion of innovation and excellence will raise the profile of high achieving Climate Control professionals while demonstrating cutting edge technological solutions and inform the industry that innovation is desirable and achievable. Refurbishment projects will specifically demonstrate options for use of new technology and control strategies in older buildings with minimum modifications to building fabric.

Initiative 3 - People

Addressing personnel and skills shortages
Providing new skill sets to existing HVAC professions, technicians and system operators
Creating new training opportunities for new entrants
Creating new transferable, nationally standard, market recognised qualifications and certificates of competency

Priority 1
Training System Operators and Practitioners

Objective
Developing operator skills for facilities managers, building services contractors and tenants and improve the expertise of climate control professionals.

Obstacle
Too often the people who have daily interaction with HVAC systems, such as facilities managers, building maintenance personnel and tenants, have insufficient understanding of the HVAC systems, the controls they have available to them, and the thermal dynamics of the buildings, to achieve optimal operation of the systems or to direct maintenance and improvements to those systems. Valuable, day-to-day operational observation of performance of systems is lost because those with daily exposure to systems performance do not know what is relevant to record to provide professionals with useful information to analyse system performance.

In many instances practitioners (service and maintenance personnel, trades people and engineers) in the Climate Control industry would benefit from possessing a wider range of systems analysis skills, and a deeper understanding of issues and skills closely related to their areas of specialisation.

I3 P1 - Response 1:
Smart Operators

Using existing training and education providers, and in conjunction with such initiatives as the Facilities Management Action Agenda, develop materials to integrate into existing curricula and the Continuing Professional Development (CPD) programs of industry associations for the education of facilities managers, members of building management committees and other stakeholders in the commercial building sector.

Target
Development and delivery of two stage course and appropriate qualification for facilities managers, members of building management committees and other stakeholders by end of Year 1 of strategy. Expansion of materials to advanced course and qualification for facilities managers by end of Year 2 of strategy.

I3 P1 - Response 2:
Smart Practitioners

Develop quality marks and certification standards for different classes of Climate Control practitioners underpinned by competency tests and training that creates a holistic understanding of HVAC and control systems, building performance and mechanical services operation, maintenance regimes and the new codes, standards and documentation systems proposed in the HVAC HESS. Promote the value of those skill sets to the market.

Target
Comprehensive national plan for expansion of existing professional development courses to deliver training and qualifications at different degrees of competency for Climate Control Professionals by end of Year 1 of strategy.

Expected Outcomes
For buildings, owned and/or managed by professionals who complete the Climate Control training package, it is expected that the greater understanding of system optimization options, the opportunities to save energy and get longer service from systems and the uses and value of the HVAC HESS documentation systems and tools will lead to:

- Tenders for service contracts of HVAC systems and controls being more thoroughly and effectively documented, leading to contracts not necessarily being awarded on lowest cost.
- HVAC systems being regularly cleaned reducing energy use;
- HVAC systems getting more regular and properly documented preventative maintenance checks;
- HVAC controls being actively used to manage demand and deliver operating efficiency;
- Observations of daily operating characteristics being recorded to assist maintenance and analysis of system performance;
- Documentation on system being compiled and prepared on the basis of new documentation standards.

Priority 2:
Graduate Engineer Cadetships and Climate Control Apprenticeships

Objective
Create on-the-job skills training opportunities for graduate engineers, apprentices and tradespeople.

Obstacle

High level skills and expertise in the Climate Control industry take a lifetime to develop yet long term career development paths and clear entry points into the industry are limited.

I3 P2 Response 1:

Cadetships

Negotiate commitments from large public and private sector organisations that have significant commercial, industrial or non-residential building assets to create engineer cadet positions under the charge of senior engineers and asset managers focused on building mechanical services. Facilitate funding arrangements or support for such cadetships from various public sector training programs and initiatives.

Target

250 Building Mechanical Services Engineering Cadetships by end of first triennium not including Health Services program

I3 P2 Response 2:

Health Services Cadet and Apprenticeships Program

Negotiate commitments from State and Federal authorities to create health services cadet engineer and trade apprentices' positions at major health and medical research facilities.

Target

50 Health Services Engineering Cadetships and 100 additional Health Services Apprenticeships by end of first triennium.

Discussion

Health care facilities, particularly hospitals, have the largest, most complex and capital intensive HVAC systems of any building type with as much as 38% of the total capital cost of such a facility being invested in mechanical services systems.

Health care facilities also have the most stringent and specialised requirements for operation and maintenance of HVAC systems, are most likely to invest in high efficiency equipment and systems, and aim to document, operate and maintain them to the highest standards for decades. These skill sets translate well into other specialised archival, laboratory and industrial chemistry, pharmaceutical and research environments where close control systems with stringent operating parameters are common.

Securing skilled staff to maintain and operate health care facilities is becoming a significant issue for health care facilities operators. For all of these reasons Health Care facilities offer a unique opportunity to provide a high

quality training environment and career path for Climate Control professionals at both graduate engineer and trades levels.

I3 P2 Response 3:
Climate Control Apprentices and Trades

Identify prospective partners and, in conjunction with training authorities and other stakeholders, negotiate commitments from building services contractors, facilities management organisations and other large public and private sector organisations that have significant commercial, industrial or non-residential building assets, to create Climate Control Apprenticeship opportunities for existing trades people or new entrants.

Target
300 Climate Control Apprentices positions by end of first Triennium

Expected Outcomes
Establish clear entry points for graduates and trades people into the Climate Control industry, assist develop long term career development paths for those new entrants. Assist in defining and promoting the qualities and suite of skills that are available to expert Climate Control practitioners.

Priority 3
Training Materials and Qualifications

Objective
Ensure that quality training materials are available in support of all other Initiatives and Priorities and ensure that qualifications and certificates of competency are appropriate and available to all who can demonstrate sufficient experience and skills.

Obstacle
The traditional definition of trades and engineering specialities does not adequately represent the suite of skills required to achieve expertise in delivery of Climate Control services. This is a result of historical, industrial, economic and cultural factors.

The Initiatives and Priorities of the HVAC HESS cut across many traditional fields of training and education. Effective human resource planning for the Climate Control industry requires the industry to provide additional training and educational materials and opportunities to grow the expertise of industry participants and build on their existing skills and specialities.

I3 P3 Response 1:
Sponsor, Commission and Co-ordinate Gap Analysis and Materials Development

Co-operate and provide national co-ordination with other bodies and programs seeking to develop and deliver training materials into this sector. Sponsor research and papers aimed at revealing and publicising available resources and gaps. Seek support for and convene an annual specialist conference on Climate Control training needs to bring together educators and industry. Engage industry and professional associations in development of materials and qualifications for educators. Explore with all stakeholders innovative formats and media to achieve the most effective distribution of training materials and uptake of qualifications given the demography of the industry.

Expected Outcomes
Climate Control industry practitioners come from a wide range of training backgrounds and career 'starting points' (electrical and mechanical engineers, electricians, plumbers, computer programmers, master builders, sheet metal fabricators, facilities managers etc). The provision of training materials and educational opportunities to build the expertise of these practitioners already in the industry will also produce opportunities for entry into the industry from other trades and skills areas. Training and educational opportunities via traditional training providers and via short courses, professional associations and RTO's will proliferate.

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