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A Climate of Change

A Strategy for improving the energy efficiency of Non-Residential Heating, Ventilating and Air-Conditioning Systems

Prepared by
Energy Strategies

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Foreword

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Executive Summary

Heating, ventilating and air-conditioning is an essential service in modern Australia. Effective HVAC services are vital to productivity, comfort and the simple ability to continuously occupy buildings, largely irrespective of the external weather conditions in almost every type of built environment - hospitals and health facilities, office buildings, workplaces, factories, underground mines, schools, educational and research institutions, hotels, retail malls, entertainment venues, convention centres and transport terminals.

The Australian HVAC industry services *at least* 120 million square metres of non-residential space, employs at least 95,000 people and accounts for direct spending of at least $7.1 billion per annum. Energy consumed by HVAC services in the non-residential sector in Australia is on track to produce at least 21 million tonnes, or more than 3.5.% of total national greenhouse gas emissions in 2010[1]. HVAC services outside the residential sector presently consume an estimated 9% of all electricity generated in Australia and hence are a major target for Governments looking to reduce greenhouse emissions in cost-effective ways.

Yet this industry is quite new, having grown from almost nothing in the last 40 years. It is rarely recognised as an industry in its own right, despite the scale of the services provided across all sectors of the economy, and the value delivered. The lack of recognition of the HVAC industry (even amongst its members) has had implications for training and education planning, certification and recognition of industry participants, and human resources availability

Demand for HVAC services is growing by an estimated 4% per annum as a result of natural economic expansion and new building completions, as older building stock has HVAC services added, and as more significantly hot days, and longer sequences of hot days, are experienced.[2]

Additionally, as the installed base of HVAC systems expands and ages, it becomes less efficient and consumes more energy. HVAC services are very electricity intensive. As a result, energy demand from HVAC services in Australia is a significant contributor to electricity demand growth and greenhouse gas emissions growth. Compare the current 9% with a future figure in 2020 or so to make this point

The technology itself is robust, the systems are advanced, complex and generally very reliable. Industry practitioners, however, readily agree that the technology is capable of far higher electrical efficiencies than is usually achieved. These same practitioners assert that a great many aging systems are likely to be operating in a very inefficient manner, and that the industry is suffering an increasing shortage of the multi-skilled personnel needed to over see upgrades and ensure provision of high quality HVAC services.

[1] Based on NGGI 2004 data, NGGI projections and estimating that HVAC services consume 40% of energy used in non-residential buildings (actual use as demonstrated by audits and case studies ranges from 25% to >60%).

[2] Based on analysis of hardware imports and manufacturing activity and the rate of completion of new commercial buildings.

The industry's primary client, the construction industry – and particularly property developers who are not owner/occupiers – have had little or no economic incentive to demand highly efficient HVAC systems. Building owners are responsible for plant and equipment, during both the design and build phase, and throughout the buildings life, but most of the benefits of investments in energy efficiency, i.e. reduced energy costs, will normally flow not to them, but to tenants. There are signs that the culture of the sector is changing and more economic incentives for building owners and developers to improve energy efficiency are emerging but these nascent moves must be supported by clearer market signals.

Many industry participants, building owners and operators, acknowledge that there is much that can be done to improve the efficiency of the installed base of HVAC systems and to insure more efficient systems are designed and built. However most will argue that nothing can be expected to really change unless there is an effective regulatory regime underpinning realistic compliance regimes, reporting, inspection and/or standards. Such regulation could be relatively light handed but would be very effective where the industry is also economically motivated.

Realistically the absolute quantum of energy used for HVAC services in Australia will not be reduced in the short term. However as a minimum this decade-long strategy aims to slow the rapid energy demand growth for HVAC services, cap emissions growth, and reduce the energy consumed and emissions produced per unit of services provided.

It is important to define and promote the industry in its own right, separately from the construction industry. To facilitate this profile-raising the people and businesses that design, manufacture, construct, install, commission, operate and maintain the complex systems which deliver Heating, Ventilating and Air-Conditioning services are referred to in this report as '*the Climate Control Industry*'.

Just as the HVAC systems that deliver comfort conditions to the vast majority of Australians every day are complex, so too is the Climate Control industry, and the long supply chain the industry encompasses. A strategy designed to address the obstacles to energy efficient outcomes in this class of technology has to deal with a number of different issues and take a variety of approaches. The ten year plan proposed encompasses 9 priority project areas and 23 targeted responses. These projects can build a foundation for a comprehensive, national industry strategy to underpin long term improvements in the energy and economic efficiency of HVAC services, and foster the overall development of a healthier, more resilient Climate Control Industry in Australia.

Brief Review of the Current Situation

The Climate Control Industry in Australia is affected by several significant market, structural and cultural obstacles that mitigate against routinely achieving high levels of energy efficiency in the operation of systems.

For decades there has been little or no incentive of sufficient value to ensure selection of highly efficient HVAC systems other than for owner-occupied buildings. A number of other obstacles, which are explored in more detail elsewhere in this report, result from this simple fact. However predominant among them is the fact that, where investments in energy efficiency do not lead to economic return, the vast majority of HVAC systems are selected based on the lowest capital cost.

There are a number of factors that make this situation challenging to change.

> The Climate Control industry's major client, the construction industry, generally regards HVAC systems as the largest single risk in a construction project (for both the chance of cost over runs and time delays). To minimise risk, standard and proven HVAC system designs are installed in most new buildings and in refurbishments rather than more innovative and energy efficient designs and systems. As such, innovation in delivery of HVAC services is rarely given an opportunity to be demonstrated nor can the costs of training and professional development required to develop a skilled workforce capable of delivering innovative systems easily be passed onto the construction industry.
>
> The installed base of HVAC systems, delivered in the culture of cost driven inefficiency and static designs described above, is both expanding and aging. It follows that it is less energy efficient than it could be. Building owners generally have little or no incentive to invest any more than is required to simply continue to deliver adequate comfort levels to tenants, even though simple and relatively cheap additional investments can often yield substantial energy and operating cost savings..
>
> In this first-cost culture, maintenance contracts are also normally awarded on the lowest tendered price and in most cases are not specified in sufficient detail with regards to efficiency and performance outcomes. Further they are delivered by personnel who generally do not have all of the skills required to bring an expert systems approach to large HVAC systems. Maintenance personnel are usually drawn from one of the several important trades (such as fitting and turning, refrigeration, electrical, plumbing or even general engineering) but will often lack skills from the other disciplines required for really effective HVAC maintenance. Additional training in the operation and maintenance of HVAC systems, for already skilled but specialized technicians, has potential to greatly improve maintenance regimes and outcomes. This is particularly the case in relation to HVAC control systems and interpretation and utilisation of the data control system can provide.

A significant gap in the influx of skilled personnel into the industry is widely reported as roughly coinciding with competitive deregulation of major public infrastructure and utilities in the early 1990's. This economic and historical trend, mirrored to some extent by simultaneous downsizing and a drive to cost reductions in corporate Australia, had the unforeseen consequence of diminishing the number of training opportunities at both trade and cadet engineer level.

Exacerbating the decline in training and new entrants to the industry, demand for HVAC services in both residential and non-residential applications has been growing strongly in the last 10 years. Opportunities for technicians to move into management, sales or to start their own businesses have been abundant resulting in a steady move of skilled personnel 'off the tools' and into other roles in the industry. The combination of all these factors means that the industry is now facing an acute skills shortage. This situation is expected to worsen as demand for services continue to grow with an aging population of practitioners.

System operators (facility managers) often do not have any detailed or technical understanding of the HVAC systems in their buildings. Even where control systems can provide data on operational characteristics of a system, facilities managers often do not have the skills to interpret the data, or understand the implications of the thermal performance of the building and the impacts of climatic conditions on the capabilities of the HVAC system. Valuable observations of day-to-day operation of systems that could greatly assist maintenance and control strategies are lost because facilities managers do not always understand what they are seeing, nor do they have processes in place to record phenomena they observe.

Tenants and the public have also become accustomed to enjoying very stable conditions in buildings irrespective of the external climatic conditions. More intelligent design, operation, controls and maintenance will deliver opportunities to allow internal building conditions to follow external conditions to some extent, while still providing very reasonable levels of comfort. While the practice of 'floating set points' may in some cases give rise to issues of humidity control, and would not be appropriate in all situations, it would also require education of tenants to become understood and acceptable.

Because the only performance indicator for HVAC systems is the continued delivery of nearly exactly the same conditions of comfort all year round, other outcomes of energy and economic efficiency are generally not considered and are not often measurable. Options for tracking the performance of systems across a number of relevant metrics must be explored to give all stakeholders better and more relevant measures of system performance.

This synopsis of industry views paints a pessimistic picture for the future without government intervention to overcome these structural impediments and market imperfections. The HVAC High Efficiency Systems Strategy will go a substantial way toward addressing these structural issues.

The Industry

The Climate Control Industry is relatively new but is now a significant part of the national economy.

The Climate Control Industry encompasses and employs a wide range of specialist skills from diverse trades and disciplines including sheet metal fabrication and manufacture, plumbing and electrical trades, refrigeration mechanics and science, construction skills and know how, architecture, engineering and building design, building management systems, specialised HVAC sensor and control systems and pyschrometrics (the art and science of air handling, humidity and air movement).

The relative youth of the industry and the diverse skills and expertise involved in the supply chain have meant that to a large extent the ‘industry’ has not developed a clear and recognisable profile of its own in the industrial landscape. This relative obscurity has resulted in human resources planning problems (not enough qualified people are available to continue to service the expanding installed base of HVAC systems) and technical engineering problems with installed HVAC systems. While others have recognised this problem (eg the Commonwealth Facility Managers Action Agenda and the NFEE training and accreditation initiative), the problem is now too large for piecemeal approaches to be effective. This strategy represents a real opportunity to address all needs in an effective manner.

One of the objectives of this strategy is to assist the recognition of the scope and reach of the Climate Control industry and its training and planning needs.

The Technology

HVAC systems are complex, generally robust, and affected by a multitude of individual factors relating to the unique situation and location of systems. Highly efficient design and operation of HVAC systems is said to be something involving both science and art.

The very robustness of the systems is one of the reasons that HVAC systems can be very inefficient in terms of energy use – they will continue to deliver acceptable conditions for thousands of hours while operating completely out of balance, with components simply consuming more power to overcome the effects of a malfunction somewhere in the system. .

Sustained high efficiency can be achieved through excellence in design, manufacturing and installation, but it also requires skilled operation and regular maintenance. Even though systems are capable of continuous delivery of services when operating in very poor condition, energy efficiency degrades quickly when aspects of the system or operation are compromised. Routine maintenance makes a very important difference to efficiency of operation and good maintenance regimes has been demonstrated to keep systems running at quite high levels of efficiency for decades.

One of the objectives of this strategy is to educate Climate Control industry practitioners about the impact of the industry on greenhouse emissions and to make the industry more accountable for its systems, practices and people.

Clients

The Climate Control Industry has three clients or beneficiaries:

- The Construction Industry including developers who on-sell properties upon completion, and owner/occupiers;
- Building Owners and Facilities Managers;
- Building Tenants.

The strategy looks to involve all these groups in projects to improve HVAC systems.

A Social Contract

The Climate Control Industry also has an essential social contract and economic obligation to deliver safe, effective and reliable HVAC systems across Australia's diverse climate zones. At present this social contract is manifestly fulfilled by the self evident success of the industry in maintaining invisible, high quality HVAC systems in operation in building complexes across the country. In the past, problems in this social contract were traditionally health related but, through this strategy the environmental consequences resulting from inefficient HVAC systems will also be folded into the contract.

The Challenge

The challenge is to continue to deliver the HVAC services required while using less energy. The Climate Control Industry appears ready to accept the challenge of reducing energy consumed per unit of delivered services, actively participate in the management and reduction of electrical demand peaks on electricity infrastructure where possible, and reduce greenhouse emissions (direct and indirect) from the use of HVAC systems. A number of significant initiatives are already under way by industry bodies, professional associations and consortia of stakeholders to improve aspects of the industry's capability and develop and demonstrate high efficiency systems.

The High Efficiency Systems Strategy

A Climate for Change – the HVAC High Efficiency Systems Strategy is a broad industry development strategy which aims to deliver:

- Reduced energy consumption per unit of delivered service;
- Higher skill levels for climate control industry employees;
- Better understanding and use of HVAC services by system owners and operators;
- Improved returns on capital investment in HVAC systems;
- Improved indoor air quality;
- Changed expectations of service parameters by building tenants;

- Some contribution to CBD and industrial area peak load management;
- Support and promote innovation;
- National co-ordination of initiatives and projects in pursuit of agreed industry objectives;
- Regulatory support for these objectives.

The strategy will capture these benefits by initiating a number of projects focused on the three pillars of the Climate Control Industry –

Systems ~ Practices ~ People

The strategy will be a living work in progress. It will respond to changing requirements, new information, initiatives and demands, and adapt and change focus if deemed necessary.

A watching brief on international developments in this area will also influence design and delivery of the strategy as relevant and valuable initiatives overseas, that could be adopted, are drafted into the Australian programs.

Strategy Structure

The strategy will deliver its objectives over a decade with shorter term campaigns to address priority issues.

The Climate Control Industry belives it could deliver a 20% reduction of greenhouse gas emissions per unit of HVAC services delivered over the next decade.

In the process of achieving significant improvements in the energy efficiency of HVAC systems in the non-residential built environment, this strategy is intended:

- To improve the capabilities of a highly skilled workforce;
- To improve the practices of the Climate Control Industry; and
- To improve the efficiency of the HVAC systems used in Australia.

Successful implementation of the HVAC High Efficiency Systems Strategy (HVAC HESS) will require an effective working partnership between the Climate Control industry and Australian governments. Endorsement of the objectives and priorities of the project plan by industry and governments requires commitments from both parties. A number of the responses identified would be more effective with some regulatory support and compliance regimes.

The policy instruments that are presently employed in support of energy efficiency in HVAC systems are:

- The Building Codes of Australia;

- Indoor air quality, health and fire safety regulations;
- Australian Standards;
- Australian national training standards.

All elements of the strategy will align with relevant codes and regulation. Where new codes and standards are proposed, some aspects of existing regulatory regimes could be reviewed to ensure consistency and practicality of requirements to assist achieve regimes with high levels of compliance and national uniformity.

Government also has the potential to directly support the implementation of the strategy by employing the standards and practices proposed by the industry as the backbone of the HVAC HESS, in the facilities they own and facilities they occupy.

Since the need for this strategy was first identified by the Ministerial Council on Energy in November 2004 a great deal of work and a number of initiatives dealing with some aspects of the work proposed have already commenced. The very process of engaging stakeholders in considering the obstacles and remedies to high efficiency has catalysed a number of initiatives in the industry. NFEE committees have commissioned work and undertaken to fund programs that are directly relevant to this strategy. Federal and State agencies and industry associations have committed funds to activities that deliver some parts of some of the responses identified here in.

Strategy Process

The priorities and actions identified were developed and tested in an extensive consultation process with stakeholders along the HVAC supply chain.

A substantial discussion paper exploring reasons why HVAC systems did not often achieve high levels of energy efficiency was widely circulated in September 2005. At the same time presentations about the paper were made at two industry conferences. This paper attracted 30 written responses and numerous emails and calls.

An industry steering group was formed in November 2005 and four working parties established with briefs to research and develop proposals for work across four broad areas;

- Documentation, Commissioning and Maintenance processes
- Education and Training
- HVAC Performance Measures and Ratings
- Industry Statistics.

A second discussion paper setting out a number of commonly acknowledged obstacles to efficient outcomes and proposing a range of remedies was circulated in May 2006. This paper attracted a further 25 written responses and considerable other informal communications. Several presentations were made about aspects of this paper and the responses to different parts of the industry in a series of industry seminars.

Draft recommendations incorporating the intelligence provided by the industry and proposing the measures that form the backbone of the strategy were circulated in September 2006. In October 2006 a final round of industry seminars included meetings arranged by the Property Council of Australia with their members in Brisbane, Sydney, Melbourne and Perth with invites going to members in other States to attend.

A list of respondents and contributors to the final list of proposed measures is attached at Appendix 1..

The HVAC HESS

People ~ Practices ~ Systems

Initiative 1 - Systems

Technology and Innovation

Making innovation accessible, acceptable and effective.

I1-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.

I1P1 - Response 1 – Develop a suite of Climate Control energy rating, metering and monitoring tools that inform the owners, operators, service personnel and energy utilities about the energy performance, greenhouse characteristics, age and state of repair of HVAC systems.

I1P1 - Response 2 – 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.

I1P1 - Response 3 – 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.

I1P1 - 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 have 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.

I1-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

I1P2 - 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.

I1P2 - 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.

I1P2 - 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.

I1P2 - 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 2 - Practices

Codes of Best Practice, Documentation Standards and Shared Incentives

Creating complimentary codes of practice and processes of documentation and data capture that give trained operators and practitioners the information they need to optimise any system in any situation.

I2-Priority 1 – Installation and Commissioning Best Practice

Objectives - Develop the Climate Control professionals, improve standards of installation and documentation of 'as-installed' systems, develop best practice commissioning process and make it essential to effective building or system completion and achievement of building performance rating. 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 new buildings and new systems (I2P3).

Obstacles – Installation of systems is often not overseen by personnel who understand the original design intent and 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.

I2P1-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.

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

I2P1 - Response 2: Early Adopters Program – Promote and support professionals and businesses who demonstrate capacity to comply with and employ code of Best Practice Installation and Commissioning. Work with Government and industry stakeholders to get institutional and corporate sign on and adoption of the code.

I2P1 - Response 3: Incentives and Compliance - Work with Government and industry stakeholders to establish some economic incentive for best practice commissioning, establish regulatory and compliance requirements for commissioning, underpinned by effective codes and standards that are practical and effective. Make compliance with the code a condition of receiving and maintaining building performance ratings.

I2P1 - Expected Outcome – Best Practice Commissioning Certification for Climate Control professionals following training and/or demonstration of competency, and 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.

The involvement of expert commissioning engineers 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

I2-Priority 2 – Maintenance Best Practice

Objectives - Develop the Climate Control professional, develop and promote best practice maintenance and contract specification and fulfilment, 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 (I2P3).

Obstacle – Other than in Health Facilities there is little enforcement of or compliance with regulatory or legal requirements to complete any maintenance regime for HVAC systems. Systems can operate for decades without routine or effective maintenance. Operators of HVAC systems often do not possess a high level of comprehension of the systems they operate, the regulatory requirements, 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. Existing standards set out cleaning and inspection regimes that are widely regarded as impractical, unnecessary or uneconomic and as common practice has become established that does not comply with standards the value of standards overall is undermined.

I2P2-Response 1: 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.

I2P2-Response 2: 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.

I2P2-Response 3: 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.

I2P2 - Response 4: Early adopters program –Promote and support professionals and businesses who demonstrate capacity to comply with and employ code of Best Practice in Maintenance. Work with Government and industry stakeholders to get institutional and corporate sign on and adoption of the code.

I2P2 - Expected Outcomes – 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 as foreshadowed in I2-Priority 3.

I2-Priority 3 – Building Log Book and System Documentation Standards

Objective - 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.

Obstacle – 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.

I2P3 - 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.

I2P3 - 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.

I2P3 - 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 achievement or maintenance of building performance ratings.

I2P3 - 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 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.

I2-Priority 4 – Finding Shared Incentives

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

Obstacle – 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.

I2P4 - Response 1: Shared Incentives Models - 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.

I2P4 - Response 2: 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.

I2P4 – Expected Outcomes – 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 3 - People

Training and Education

Addressing personnel and skills shortages, providing new skill sets, training opportunities and transferable nationally standard qualifications

I3-Priority 1 – Training Smarter System Operators and Practitioners

Objective - Developing system operator skills and improving expertise of climate control professionals

Obstacle – In too many cases building owners and facilities managers have insufficient understanding of the HVAC systems they own and operate, the controls they have available to them, and the thermal dynamics of the buildings, to either achieve optimal operation of the systems installed or to direct improvements to those systems based on day to day operational observation of performance. In many instances practitioners (service and maintenance personnel, trades people and engineers) in the Climate Control industry could 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.

I3P1 - 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 owners and facilities managers.

Target: Development and delivery of two stage course and appropriate qualification for facilities managers, building owners 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.

I3P1 - Response 2: Smart Practitioners – Develop quality marks and certification standards for different classes of Climate Control practitioners to create and demonstrate 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 and 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.

I3P1 - Expected Outcomes – For large area multi-storey or complex buildings, owned and/or managed by owners and facilities managers who successfully complete a relevant Climate Control training package, it is expected that the far greater understanding of the opportunities to save energy and get longer service from systems will lead to:

- Tenders for service contracts of HVAC systems and controls being more thoroughly documented leading to contracts not necessarily being awarded on lowest cost.
- Systems being regularly cleaned;
- Systems getting more regular and properly documented preventative maintenance checks;
- 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.

I3-Priority 2 – Graduate Engineer Cadetships and Apprentices

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

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

I3P2 - 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 focussed 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

I3P2 - Response 2: Health Services Cadet and Apprentices Program – 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 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 such systems and 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 also translate well into some other specialised laboratory and industrial chemistry, pharmaceutical and research environments. 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. 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.

I3P2 - 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

I3P2 - 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.

I1-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 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.

I3P3 - 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 and short course delivery.

I1P3 - Expected Outcomes – Climate Control industry practitioners come from a number of training backgrounds and career 'starting points'. 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.

Strategy Realisation

Widespread industry support for the strategy is tempered by a concern that the realisation of the proposed measures must be done in a manner that involves all aspects of the industry and its stakeholders. In some cases, for instance in regard to the proposal for an 'Australian Building Log Book,' involvement of stakeholders across the Climate Control and Property sectors is required to ensure that the proposed measures confer sufficient advantages to be widely adopted without need of regulation.

It has been proposed that a industry wide forum be convened to discuss implementation processes in the new year. An industry reference group or taskforce is also under consideration as one mechanism whereby industry leaders can provide input to the implementation and oversight of development of materials and processes.

A Profile of the Climate Control Industry in Australia

To date the Climate Control industry has not been an industry that has been defined in its own right. It has largely been hidden in the national statistics, aggregated into data collections in other sectors, primarily the construction industry. As a result, data sources are limited and the most conservative projections and multipliers have been used. The figures herein are significant underestimates and should be regarded as something of an economic 'sketch' of the industry. However, we believe they provide a starting point from which various industry participants can begin to fill in gaps in data. Updates of this short report will be issued periodically as new data is provided or discovered.

GREENHOUSE GAS EMISSIONS[3] 21.9Mt pa in 2010 ~ 3.6% of national total

Based on 40% of energy used in commercial buildings [4] being consumed by HVAC systems (upper range estimates are up to 60%) then by 2010 emissions produced by energy used in HVAC systems will be 21.9Mt per annum or 3.6% of projected national emissions in that year.

ENERGY – 9% of Australian Electricity Production ~ 63PJ Electricity, 30PJ Gas

Again, using the 40% estimate for the proportion of energy consumed in commercial buildings being used by HVAC systems, then approximately 63PJ of electricity per annum is consumed in HVAC systems (being ~9% of all electricity consumed in Australia and responsible for 91% of the greenhouse emissions from HVAC energy consumption). A further 30 PJ of natural gas is also consumed in HVAC equipment. The cost of this energy to consumers is estimated at approximately $2.2 billion dollars pa.

SCALE – 120 Million Square Metres of Non-Residential Buildings enjoy HVAC

CSIRO estimates that there are between 180 million and 200 million m^2 of all types of non-residential buildings in Australia. The Property Council of Australia now tracks more than 20 million m^2 of commercial office space. For the purpose of this estimate we are assuming that at least 60% of the upper estimate of this space has some climate control services. Therefore there is at least 120 million m^2 of buildings in Australia serviced by some form of electrical and/or gas heating, ventilation or air-conditioning system.

EMPLOYMENT – At least 95,000 directly employed

The Australian Refrigeration Council has reported that more than 15,000 individual licences have been issued for experienced personnel and trainees working on stationary air-conditioning and refrigeration. They also report as many as 10,000 businesses operating in this sector. Following consultation with equipment manufactures, mechanical contractors and engineers we estimate that there are at least another 5.33 people employed in the industry for every licenced refrigeration technician, thus a total of 95,000 employees.

BALANCE OF TRADE 2006 – Net Imports of $506 million

Based on available Customs and ABS data

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[3] Estimates of direct emissions of refrigerant gases are not included.

[4] Estimates of energy used in the commercial sector based on ABARE Fuel and Electricity Survey data and Pupilli 2004 for SEAV.

Imports 2002/03 equals $460 million. These figures include only commodities that are explicitly categorised as air conditioning equipment. They exclude imports of other system components, e.g. control equipment, which are used in HVAC systems, but also in many other types of systems and installations. It also excludes the value of imports of refrigerant gases.

Thus, adjusted up by a very modest 10% for control equipment, electric motors, pumps and fans, filtration materials and other equipment and consumables not classified in the data as HVAC equipment total imports in 2002/03 would be $506 million. Less 2002/03 exports of $73m. Thus Net Imports 2002/03 $433 million.

Inflate by 4% per annum to 2006 – thus Net Imports 2006 = $506 million.

Note that ABS data for 2003/04 indicates that imports of the categories of equipment that were included in the above figures grew by 8%, however it is assumed that a significant proportion of that import growth can be accounted for in the rapid growth in demand for residential air conditioning systems. This is certainly indicated by other data relating to the volumes of refrigerant gases imported with the majority of these imports being in pre-charged smaller air-conditioning systems. Thus the 2002/03 net imports figure is only inflated by 4% per annum to give a 2006 estimate of $506 million of net imports (this also assumes that exports grew at the same rate.)

About half by value of total imports come from Thailand and about a quarter from Japan. The balance come from a number of different countries, but imports from China have been growing rapidly in the last two or three years.

MANUFACTURING OUTPUT 2006 - $766.5 Million

2002/03 Industrial air conditioning units $181 million

2002/03 Selected materials and components (includes products which may be used in non-HVAC applications)[5] ~ $593 million. Discount by 30% to avoid counting material not consumed in HVAC applications therefore $415.1 million. Add the value of industrial air conditioning units manufactured in Australia, thus total of $596.1. Add back in 10% to account for components, materials and consumables used on construction sites and in installation, thus $655.7 million. Inflate by 4% per annum to 2006 thus $766.5 million.

EXPENDITURE ON NEW SYSTEMS 2006 - $2.5 Billion

A. Net Imports	~ $506 million
B. Manufacture	~ $766.5 million
C. Total Hardware (A+B)	~$1,272.5 million
D. Installed cost (C x 2)[6]	~ $2,545 million

[5] Sheet metal ducting, non-electric iron or steel radiators for central heating; air heaters and hot air distributors incorporating a motor driven fan or blower, compressors for refrigerating and air conditioning equipment.

[6] Equipment cost 50%, labour cost 50%

An alternative approach to this number involves applying an accepted industry estimate of the value of mechanical services work as a percentage of construction value in non-residential buildings. While this proportion varies considerably across different types of building stock from as high as 37% in health facilities to as low as 4.8% in 'factories', industry informants accept an across the board average of 12.5%.

Applying this percentage value to the Australian Bureau of Statistics estimate of non-residential construction in Australia in 2005 of $19.8 billion, the value of mechanical services in 2005 would have been equal to $2,475 million. Inflating by 4% to a 2006 value gives $2,574 million for 2006.

Testing these two figures on equipment manufacturers and importers verified the range of estimates and leading industry associations have agreed that a round number of $2.5 billion for the value of new systems in 2006 aligns with their knowledge of the market for new systems.

EXPENDITURE ON CONSULTING ENGINEERS ~ $450 Million

Consulting engineers can be used at various points throughout design, manufacture, installation and commissioning of systems. A reliable and low estimate is that consulting engineers on mechanical services would cost ***at least*** 2% of total construction costs. Based on a 2006 estimate of $20 billion in non residential construction that indicates at least $400 million expenditure on consulting engineering services. Another approach to estimating costs of consulting engineers is to consider employment numbers. It is safely estimated that there are 3,000 consulting engineers employed in the mechanical services area and that they would each employ at least one other full time person assisting them. Average salaries in this professional services area are estimated at $75,000 per person. This estimate would indicate that total consulting fees might be worth $450 million per annum. In consultation with industry it was decided that the higher figure is a more likely value.

EXPENDITURE ON MAINTENANCE ~ $600 Million

Property Council of Australia estimates of the cost per square metre per annum to maintain mechanical services average slightly more than $6. However as there is certainly a percentage of the installed systems in building stock where maintenance is minimal or undertaken only when breakdowns occur an average figure of $5.00 per mt^2 is used for this estimate. Industry informants concur with this value. 120 million mt^2 of buildings at $5.00 per annum = $600 million.

UPGRADE COMPONENTS, REFURBISHMENTS, ADD-ONS ~ $1,350 Million

There is a significant level of activity in the market that does not require building permission and thus would not be captured in the ABS statistics as construction activity. However based purely on interviews with manufacturers, importers, mechanical services contractors and industry associations an estimate for this market of $900 million a year in sales of equipment has been agreed. While the wage and salary costs are normally expected to be 50% of the value of new systems, as there are significant elements of HVAC systems that are very rarely replaced through out the life of the system, and they are also the less capital intensive elements such as ducting, vents, plumbing etc, a low labour cost multiplier is used against the capital value of the refurbishments market of only 30% of the final cost. Thus the $900 million in equipment sales could result in another $450 million in labour. Total value of the upgrades, refurbishments and add-ons market is thus estimated at $1,350 million.

ESTIMATED SPENDING ON NON-RESIDENTIAL HVAC SYSTEMS 2006 - $7.1

Energy Spend	~ $2,200 million
New Systems	~ $2,500 million
Consulting Engineers	~ $ 450 million
Maintenance	~ $ 600 million
Upgrades, Replacements	~ $1,350 million
Total	**~ $7.1 Billion**

An alternative way of seeking to estimate the total spend by the industry is via employment. Assuming that the industry estimates of a further 5.33 persons on average employed for each refrigerant technician license holder are correct, thus giving total employment of 95,000, and that average wages in the industry equal the national average annual earnings ($51,637 in 2006), then the total value of wages and salaries is $4.91 billion. If this figure is reasonably accurate then adding the hardware value of new systems, the hardware value of upgrades and the energy spend would, then give a total value of the industry closer to $9 billion than the $7.1 billion shown above. This would be around 1.1% of Australia's GDP.

These estimates of direct spending on the construction, installation, operation and maintenance of HVAC services in non-residential buildings will continue to be refined as more data becomes available.

BROADER CONTRIBUTION TO ECONOMIC ACTIVITY AND SOCIETY

Incalculable. HVAC services in the non residential market are an essential service contributing directly to the comfort, well being and productivity of the workforce, the maintenance of essential computing and telecommunications infrastructure and the preservation and storage of valuable goods.

COMMENTS should be provided to michael.mccann@energystrategies

Appendix 1 – Contributors

The following list includes those organisations and individuals who made some form of substantial contribution to the development of the strategy and who were not on the industry steering group. They are listed separately below. Many of the members and staff of industry associations listed had some input through their association.

Air-conditioning and Refrigeration Equipment Manufacturers Association of Australia
Air-conditioning and Mechanical Contractors Association
Australian Institute of Refrigeration Air-conditioning and Heating
Aynsley, Dr Richard - Big Ass Fans
Ballard, Allen - A&R Airconditioning Pty Ltd
Bannister, Paul - Exergy
Barry, Tom – Department of Industry, Tourism and Resources
Bathish, Hassan - Eco Energy, KL, Malaysia
Bong, Chris - Advantage Air, WA
Bordass, Bill – Usable Buildings Trust
Bradwell, Simon
Carr, Ray - Discount Air
Cullen, Rob - Rob Aire Pty Ltd****
Davies, Hywel – CIBSE Research Manager UK
Electrical College Board
Green Building Council of Australia - Nigel Howard COO
Hines, Leonard - George Floth P/L Senior Engineer
Insitute of Engineers Australia
Israel, Andrew - Fans Direct Managing Director
Johnson, Paul C - Aerodynamic Developments
Kennedy, John ABCB
Kozlov , Paul - Power Pax
Lacey, Gordon - Munters, Division General Manager
Lane, William - Aircontech
Leaman, Adrian
Lee, Trevor - Energy Partners
McNicol, Ian - Sustainability Victoria
Patterson, Mark
Parrello, Frank – Dept of Transport, Energy and Infrastructure, SA
Precious, Bruce - ECS
Price, Bryon - AG Coombs
Property Council of Australia
Ryan, Wayne - Air Con Serve Pty Ltd
Sangster, Allan Chair, Electrical Branch Syd. IEAust
Shallcross, Grant - Aeris Technology Managing Director

Tatam, Glen - ACMV Consultants
Thompson, Rhys - AirEng Pty Ltd
Whish-Wilson, Chris - Degree C Managing Director
White, Stephen - Australian Chair IIR and Distributed Energy Manager CSIRO Energy Technology
Williams, Troy - Australian Institute of Buildings

Members of the Industry Steering Group

Greg Groppenbacher – Chair

Jo Archibald – DASCEM Pty Ltd

Phil Wilkinson – Technical Director AIRAH

Jennifer Pelvin – Past CEO AIRAH

Dr Ernest Donnelly – Technical Advisor to project